POPULAR SCIENCE

FOUNDED MONTHLY 1872

MARCH

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POWER FROM POLAR GALES

Page 25

NEW INVENTIONS · MECHANICS · MONEY MAKING IDEAS

Car Operating Costs *Keep on* Tumbling!

OWNERS REPORT 18 TO 24 MILES PER GALLON OF GAS IN 1936 PLYMOUTH... ALSO NEW ECONOMIES IN UPKEEP

ENGINEERING GENIUS has attained sensational gas economy in the Plymouth car by super-high compression (6.7 to 1). No premium fuel is required and owners report 18 to 24 miles a gallon. To get this very high compression without spark-knock, engineers developed calibrated ignition...the spark is kept advanced by vacuum and automatically retarded during acceleration or heavy pulling.

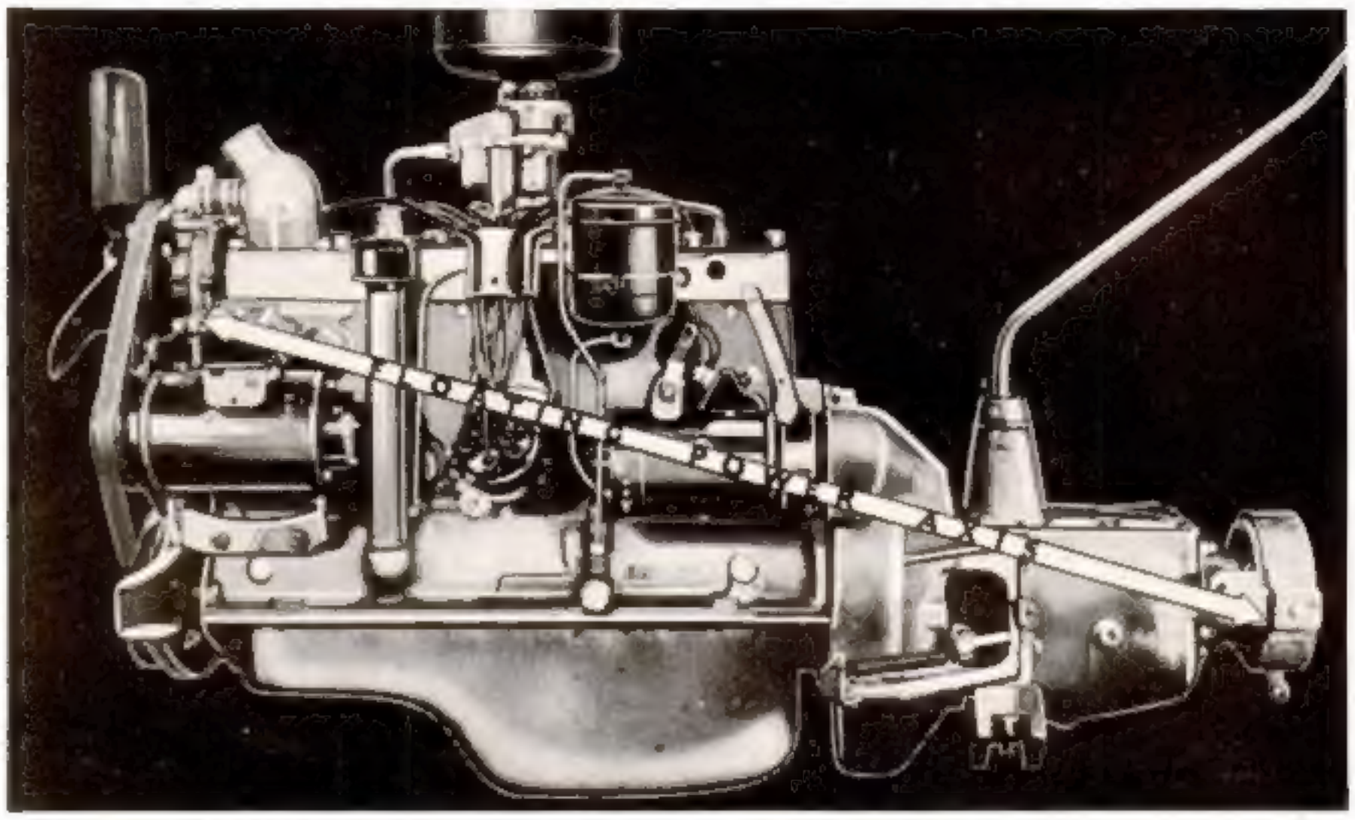
The cooling problem they solved by *full-length* water jackets and directional circulation at high velocity to all parts of the cylinder block.

Plymouth's safe 100% hydraulic brakes save brake adjustments. The Safety-Steel body cuts out the usual repair costs.

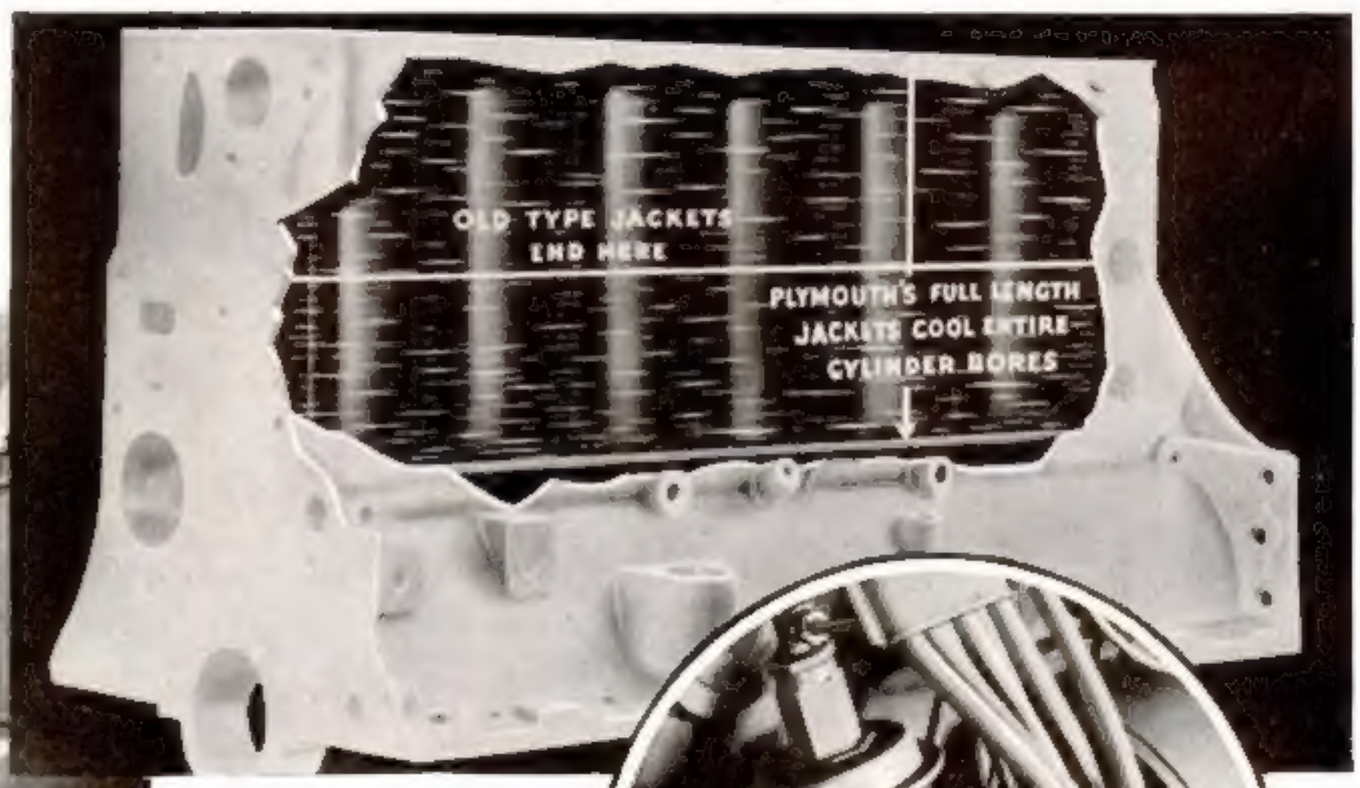
Ask your Chrysler, Dodge or De Soto dealer to let you drive the 1936 Plymouth. Price is only $510 (and up, list at factory, Detroit. Special equipment extra)

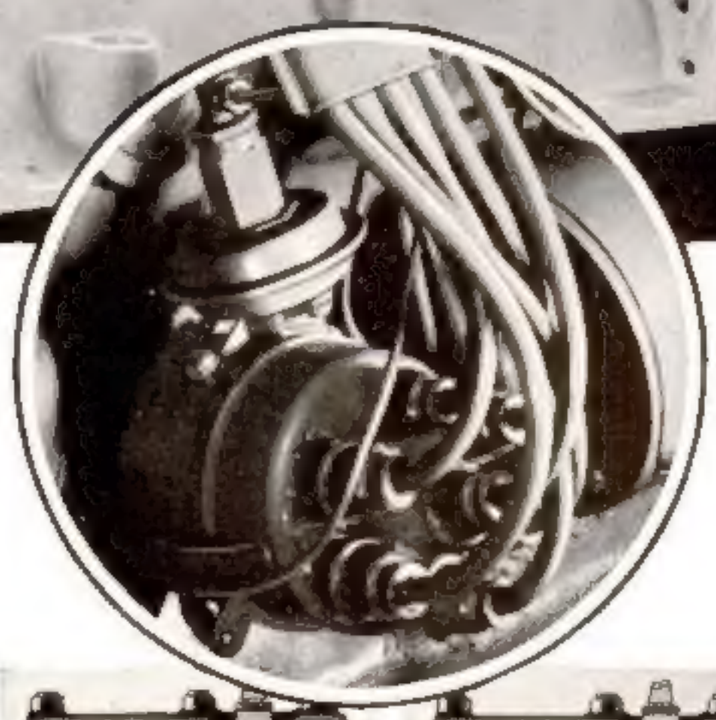
PLYMOUTH DIVISION OF CHRYSLER CORP.

Insist upon 100% hydraulic brakes.



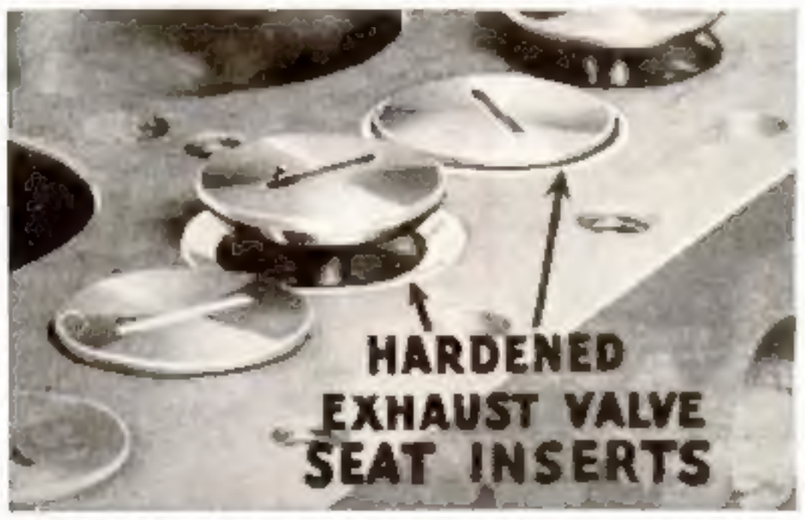
Plymouth's 6-cylinder engine...with patented "Floating Power" engine mountings that eliminate vibration (both unpleasant and a cause of repair expense).





(*Above*) Full-length water jackets and directional cooling help make possible sensational economy.

(*Right*) Calibrated ignition that eliminates "ping" and gets all the power from every drop of gasoline consumed.



Special heat-resisting exhaust valve seat inserts —they save money on valve-grinding costs.

Ask for the New

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6% TIME PAYMENT PLAN

You can figure it out for yourself.

1 Start with your unpaid balance.

2 *Then add insurance cost.

3 Then multiply by 6%—for a 12 months' plan. One-half of one per cent per month for periods more or less than 12 months.

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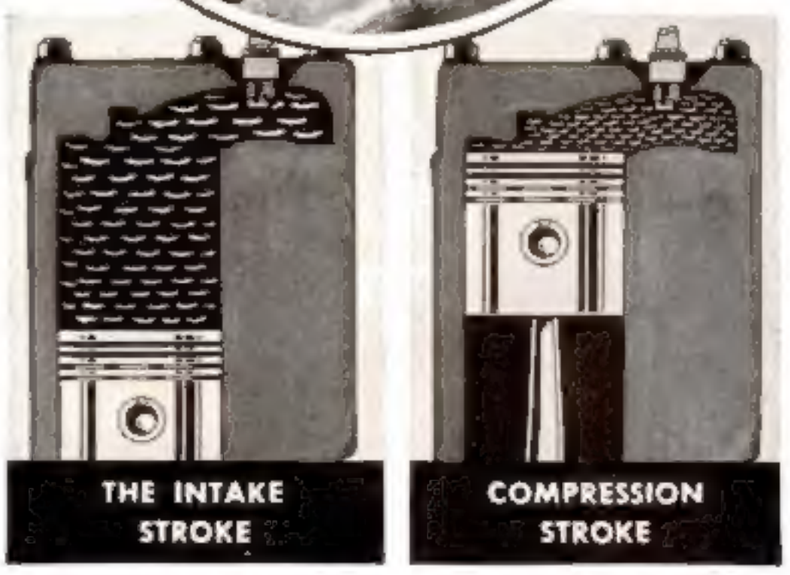

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and 243 More!

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The Cop and the Anthem
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The Caliph and the Cad
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The Fool Killer
A Sacrifice Hit
Past One at Rooney's
A Philistine in Bohemia
Cherchez la Femme
Handbook of Hymen
The Brief Debut of Tildy
Transients in Arcadia
The Shocks of Doom
Man About Town
From the Cabby's Seat
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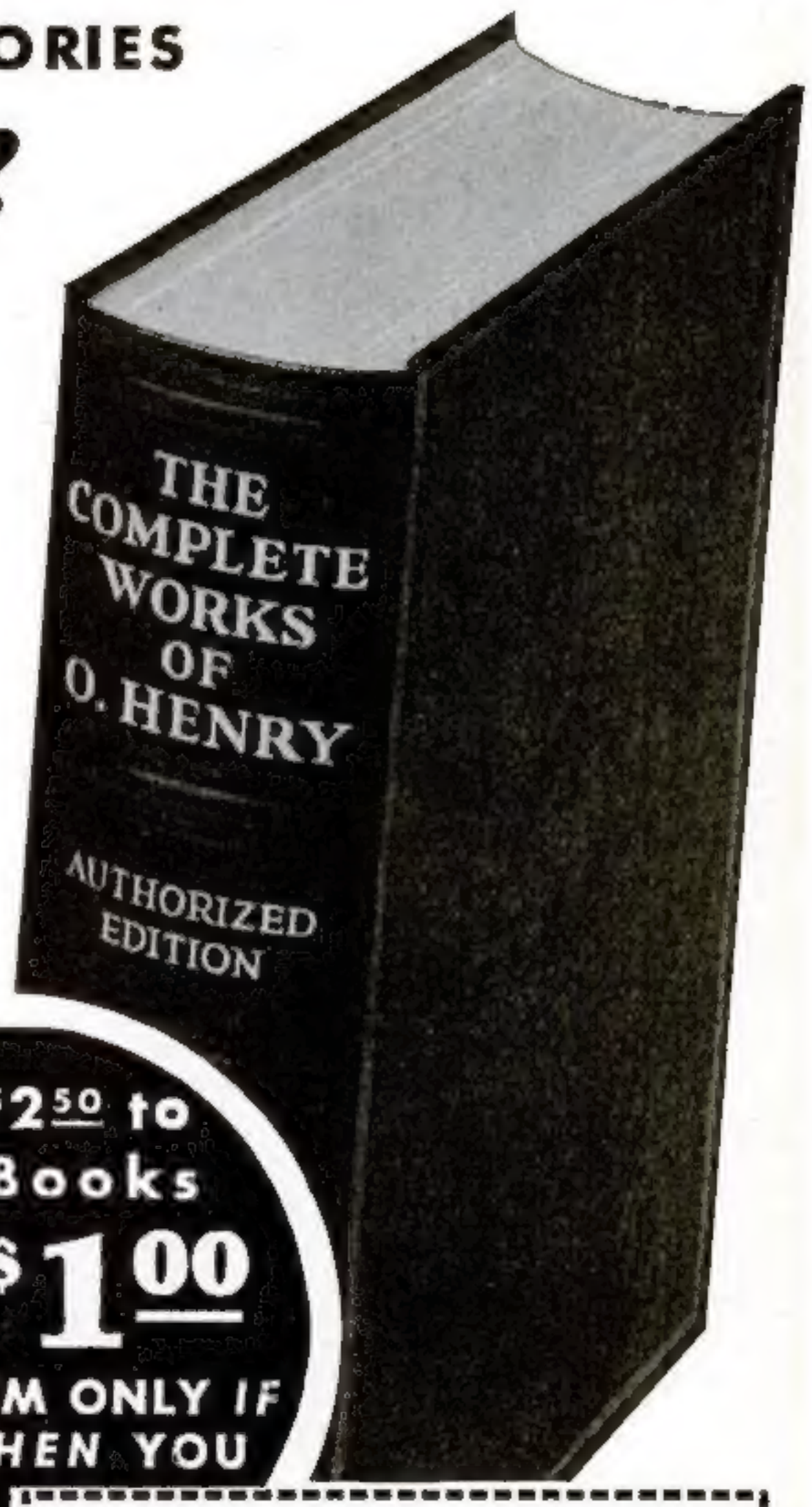
Between Rounds
Cupid a la Carte
Roads of Destiny
The Gift of the Magi
A Service of Love
The Lady Higher Up



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FEATURES AND DEPARTMENTS

Cover Design by EDGAR F. WITTMACK

AUTOMOBILES

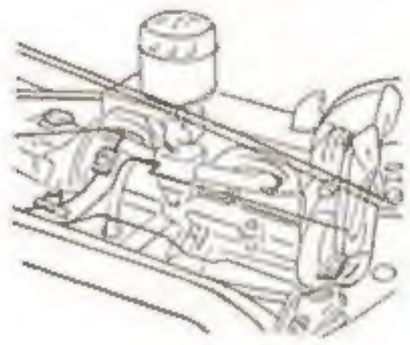
AVIATION

SMOOTHER, LIVELIER POWER!

POWER in the 1936 Oldsmobile Six and Eight is smoother at every speed . . . performance more responsive in traffic, on the hills and on the open road. Electro-hardened aluminum pistons . . . lighter by 50% . . . and many other engineering advances contribute to Oldsmobile's velvety, spirited and economical performance. A few are pictured on this page. For a complete study of Oldsmobile's outstanding performance advantages, write to Olds Motor Works, Lansing, Mich., and ask for Free Catalog and 1936 Oldsmobile Engineering Information.

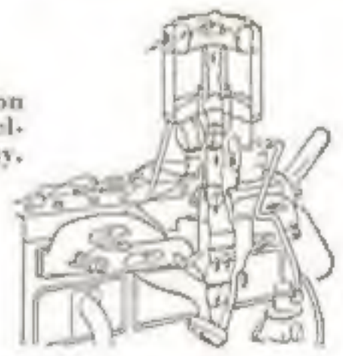
Oil under pressure is carried to the piston pins through rifle-drilled passages in the connecting rods. Special spurt holes in the rods spray oil on the cylinder walls before pistons reach top of stroke.

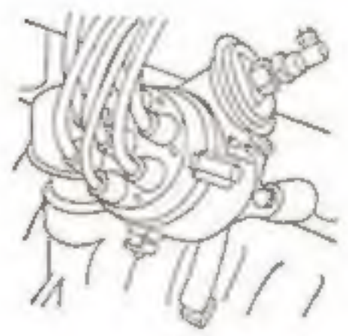
Oldsmobile's crankshafts are accurately counterweighted and balanced both statically and dynamically. A vibration damper neutralizes torsional vibration. These features add to Oldsmobile's operating smoothness and insure maximum main bearing durability.



Tri-cushion Engine Suspension, in which the engine rides on large, live rubber mountings, absorbs vibration and engine movement—assures quiet operation in all speed ranges, contributes greatly to Oldsmobile's smoothness of performance.

New-type down-draft carburetion provides easier starting, quicker acceleration, greater power, more economy. Automatic choke control, built integrally with the carburetor, insures positive operation and simplifies cold weather starting.





The exact automatic spark advance for greatest gasoline economy is provided by Oldsmobile's new Vacuum Spark Control and Fuel Saver. Actual road tests prove that the Vacuum Fuel Saver provides a marked increase in miles per gallon. This new engineering development also eliminates "spark knock".

Send For The COMPAR-O-GRAPH

a handy device for checking and comparing features offered in 1936 motor cars . . . it's free for the asking. Simply fill in this coupon and address it to Olds Motor Works, Dept. S, Lansing, Michigan.

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POPULAR SCIENCE MONTHLY FOR MARCH, 1936

In This Issue—Hundreds of Fascinating Articles Tell the Latest News of Laboratory Discoveries, Scientific Triumphs, and Amazing New Inventions

★

SHE'S A PARTNER IN A GREAT AMERICAN BUSINESS

She is one of 850,000 owners of Bell System securities. They are typical Americans—some young, some middle age, some old. They live in every part of the nation.

One may be a housewife in Pennsylvania. Another a physician in Oregon—a clerk in Illinois—an engineer in Texas—a merchant in Massachusetts—a miner in Nevada—a stenographer in Missouri—a teacher in California—or a telephone employee in Michigan.

For the most part, Bell System stockholders are men and women who have put aside small sums for saving. More than half of them have held their shares for five years or longer. More than 650,000 of these 850,000 security holders own stock in the American Telephone and Telegraph Company—the parent company of the Bell System. More than 225,000 own five shares or less. Over fifty per cent are women. No one owns as much as one per cent of the stock of A. T. & T. In a very real sense, the Bell System is a democracy in business—owned by the people it serves.

Over 270,000 men and women work for the Bell System. One person out of every 150 in this country owns A. T. & T. securities or stock and bonds of associated companies in the Bell System.

BELL TELEPHONE SYSTEM

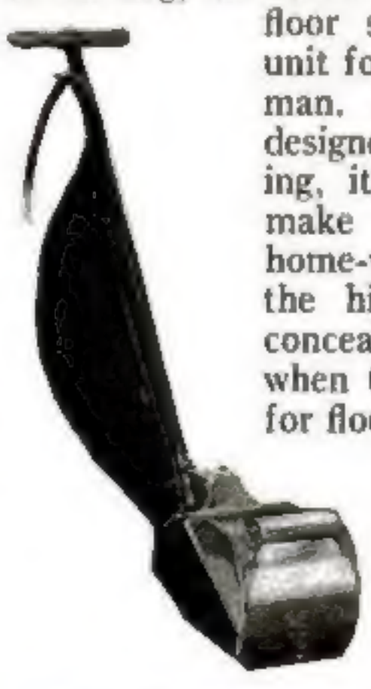
HANDY AIDS FOR Home Mechanics

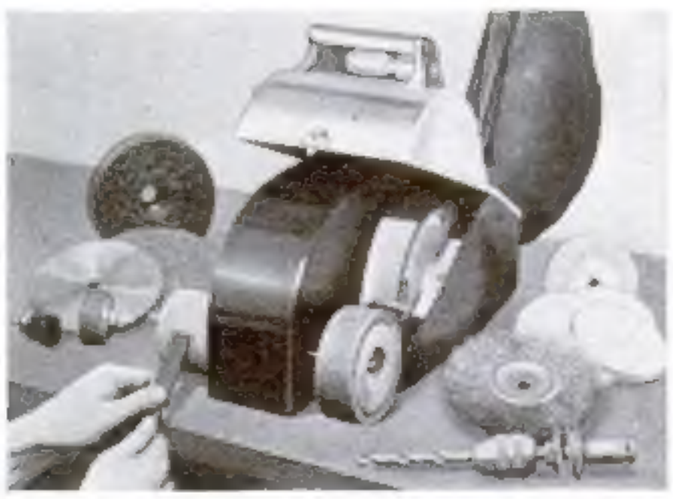
MAKES GALVANIZED IRON TAKE PAINT EASILY

ANYONE who has done much house painting knows how difficult it is to make paint stick to galvanized iron surfaces such as down spouts and eaves troughs. With a new chemical primer now on the market, however, the problem is simplified. Sold as a liquid, it is either painted or sprayed on the cleaned galvanized surface. When dry, the primed metal, after cleaning, is ready for painting. The primer will not wash off, chip, or corrode.

FLOOR SANDER HOUSES POWER-TOOL UNIT

BECAUSE it can be used for sawing, drilling, grinding, buffing, and polishing as well as sanding, the latest in portable electric floor sanders is an ideal unit for the amateur handy man. Although primarily designed for floor surfacing, its many other uses make it an all-around home-workshop tool. When the hinged cover, which conceals the power unit when the machine is used for floor sanding, is raised, the other attachments or the flexible shaft can be attached easily to the drive shaft.

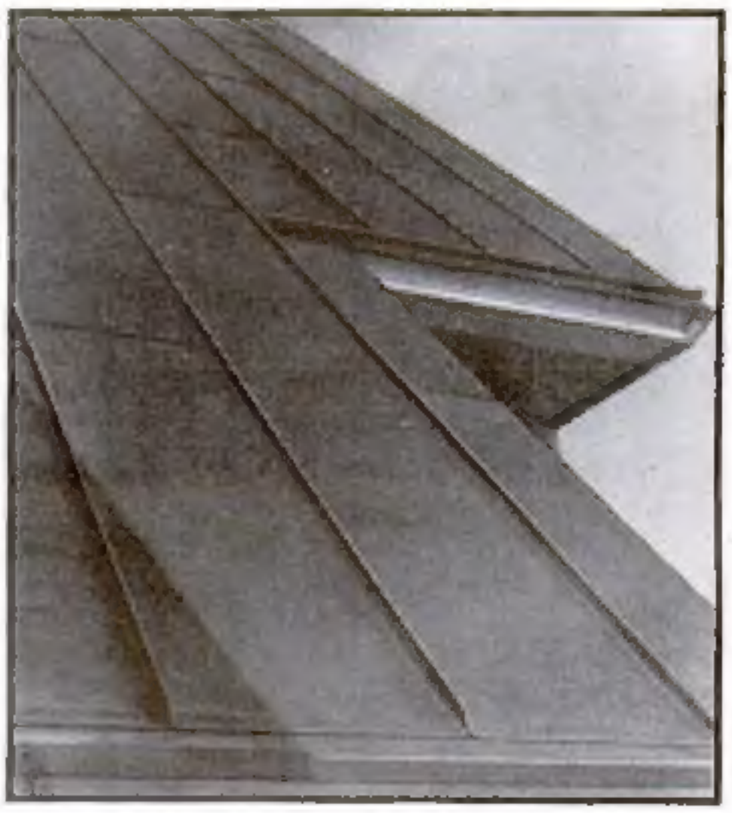




This versatile floor sander can be placed on a bench, as above, and used for many power jobs

NEW PAINT SIMPLIFIES SPANISH-COMB WORK

WITH a set of steel combs and a plastic paint now on the market, even the inexperienced amateur can obtain hundreds of decorative wall-finish effects. The paint is easy to apply and requires no shellacking or other preparation. It is simply applied to the wall, decorated with the texture of comb desired, and allowed to dry. The possible designs cover a wide range, from attractive swirls, circles, and crisscrosses to any of various combinations like that shown above.



LOW-COST COPPER ROOF

DESIGNED for use on small homes, a new thin, lightweight copper roofing brings a long-wearing copper roof within the means of the average home owner. Weighing a little more than half as much as old-style copper roofing, this new material costs no more than many other high-grade roofings. Its lighter weight also makes it easier to work, while its narrower width lends itself to small-home architecture.

Questions

FROM HOME OWNERS

Q.—IS THERE any quick way of removing old putty from window frames?—R. F. S., Worcester, Mass.

A.—PUTTY is usually cut out cold, special "hacking" knives being sold for the purpose. Another method, however, which is said by many painters to be a time saver, consists of heating an iron rod, such as a poker, and applying it to the putty to soften it.

SPONGE IS SECRET OF STIPPLING

Q.—HAVE tried using a sponge for stipple painting without much success. Does the sponge require any special preparation?—W. W., Harrisburg, Pa.

A.—IN ORDER to get an even stipple pattern, the sponge must be cut to provide a flat surface. This can be done most effectively by soaking the sponge in hot water and then trimming it while wet with a large pair of sharp scissors. When ready to start stippling, soften the sponge in water and wring it until moderately dry.

MIXING WALL-PAPER PASTE

F. R. P., NEW YORK, N. Y. Although a thick paste should be used when applying heavy wall paper, lightweight, cheaper papers require a thinner mixture. The condition of the wall surface also should be taken into account when mixing the paste. A porous or rough wall requires a thick paste, smooth walls require a thin paste.

WHITE SPOTS ON BRICK WALLS

Q.—I HAVE painted the brick foundation walls in my cellar aluminum color, but am having difficulties keeping the surface free of a chalky, white substance which seems to ooze from the bricks along the mortar lines. Is there any cure for this?—I. S., Minneapolis, Minn.

A.—THE spots undoubtedly are a white efflorescence caused by soluble salts in the mortar. If the wall is inclined to be damp, treat it with a commercial waterproofer. If the wall is dry, it is possible that the efflorescence can be checked by cleaning the wall thoroughly, allowing it to dry, and applying another coat of paint, preferably a high-grade, outside spar varnish.

CLEANING PEBBLED STUCCO

P. F. T., DALLAS, TEX. Stucco that has a rough or pebbled finish and is badly soiled sometimes can be cleaned by washing with a muriatic acid solution. Add one part of the acid to eight parts of water, apply it with a coarse broom or brush, and rinse thoroughly with cold water. Finally, to remove every trace of acid, apply a solution of one part ammonia in eight parts of water.

MATCHING JOINTS IN LINOLEUM

H. K. D., CHICAGO, ILL. To make a perfect joint between two pieces of linoleum when covering a floor, lap one piece over the other and cut through both with a sharp steel knife. If the linoleum has a definite design, make sure that the design is unbroken by the lap before cutting.

NAILS HELP PLASTER TO STICK

T. E., SCHENECTADY, N. Y. When a large patch is to be made in a plaster wall, drive common nails into the exposed wood or lath, sinking their heads below the surface of the wall. They will help to hold the plaster in place.

Kits for Building Ship Models

KIT 4S—Materials for *Great Republic*

THE largest and in many respects the most remarkable clipper ship ever built in the United States was the *Great Republic*. For those who wish to build a model of her, we are offering a construction kit that contains all the necessary raw materials and full-size blueprints. The hull is 31½ in. long; the over-all size of the finished model is 42 in. long and 23½ in. high. Not only is it the largest clipper ship model we have ever presented, but by far the most complete in every detail. The model, if carefully made, is worth more than $100, but the price of the construction kit is only $8.40 (50 cents extra west of the Mississippi River and in Canada).

For convenience, our ship model kits have been divided into three classes. The standard models, of which the *Great Republic* is an example, are the most advanced. The simplified models are of the same general construction, but very much smaller and easier to make. The hulls are supplied semifinished. Still simpler are our Model-of-the-Month Club kits, which require few tools beyond a pocketknife, a razor-blade knife, a pair of pliers, and a fret saw.

The complete list of our kits is as follows:

STANDARD SHIP MODEL KITS

A.	Whaling ship *Wanderer*, 20½-in.	$7.40*
D.	Spanish galleon, 24-in.	6.95*
E.	Battleship U.S.S. *Texas*, 3-ft.	7.45*
G.	Elizabethan galleon *Revenge*, 25-in.	7.25*
L.	Farragut's flagship *Hartford*, steam-and-sail sloop-of-war, 33½-in. hull	8.45*
Q.	Privateer *Swallow*, 12½-in. hull	4.95†
V.	Clipper *Sovereign of the Seas*, 20½-in. hull	4.95†
Y.	Trading schooner, 17½-in. hull	4.90†
2S.	U. S. Destroyer *Preston*, 31½-in. hull	5.95*

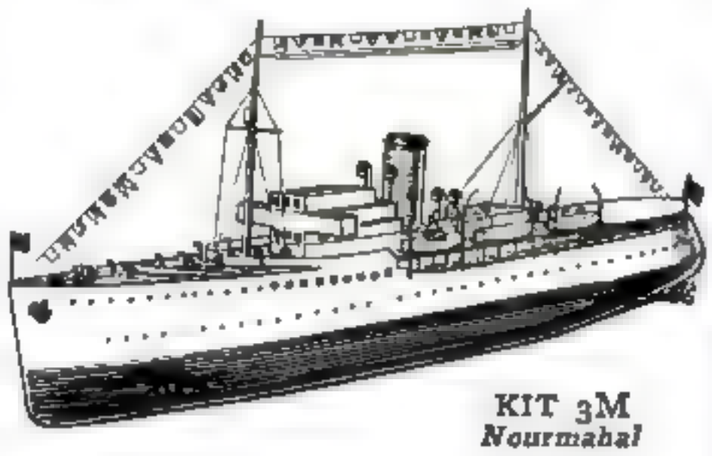
(List continued on following page)

KIT 2M—Ocean freighter, 14 in. long

3S. *Constitution* ("Old Ironsides"), 21-in. hull 6.50*
4S. Clipper ship *Great Republic*, 31½ in. hull 8 40*

SIMPLIFIED SHIP MODEL KITS

F. Liner S.S. *Manhattan*, 12-in..... 1.00
H. Cruiser U.S.S. *Indianapolis*, 12-in. 1.50
J. Clipper ship *Sea Witch*, 13-in..... 1.50



KIT 3M
Nourmahal

MODEL-OF-THE-MONTH KITS

M. Aircraft carrier *Saratoga*, 18-in..... 1.00
N. Four U.S. destroyers, each 6¼-in. .75
O. Liner S. S. *St. Louis*, 11-in..... 1.00
R. U. S. cruiser *Tuscaloosa*, 11¼-in... 1.00
U. *Hispaniola*, the ship in "Treasure Island," 7-in. ..... .50
Z. H.M.S. *Bounty*, 11½-in..... 1.50
1M. Show boat, illuminated, 14-in..... 1.50
2M. Ocean freighter, 14-in..... 1.50
3M. Yacht *Nourmahal*, 8⅛-in..... 1.00

KIT No. 8 has materials for whittling six Scotties

MISCELLANEOUS

No. 4. Solid mahogany book trough 22½ in. long, 9½ in. wide, and 24¾ in. high over all. Ready to assemble, with finishes..... 5.30*

No. 5. Solid rock maple hanging wall rack with one drawer, 19½ in. wide, 33¼ in. high. Ready to assemble and stain included..... 5.75*

No. 7. Whittling kit with two shaped blocks for making sea captain 5½ in. high..... 1.50

No. 8. Whittling kit for six different Scotties. Each is 2 by 2¼ in., sawed to shape 1.00

NOTE: If you live west of the Mississippi River or in Canada, add 50 cents to all prices marked with an asterisk (*) and 25 cents to all prices marked with a dagger (†). Otherwise all prices are postpaid anywhere in the United States or Canada. The kits marked with an asterisk or dagger will be sent C.O.D. in the United States upon request, but the purchaser will have to pay 28 cents additional.

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353 Fourth Avenue, New York, N. Y.

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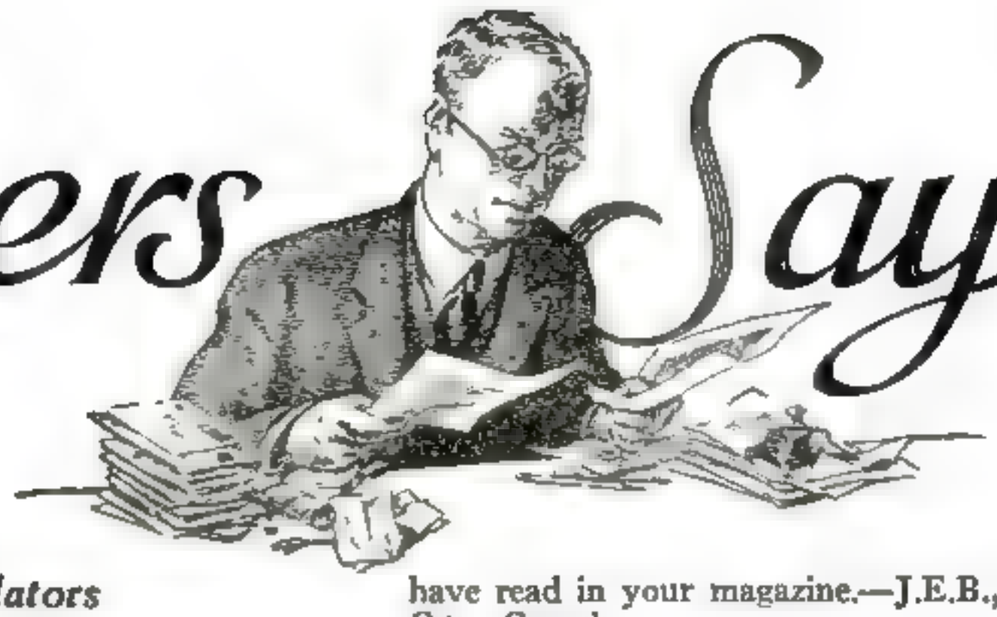
City..... State.....
(Print name very clearly.)

Remit by money order, check, or registered mail. No kits selling for less than $4.00 can be sent C. O. D. This offer is made only in the United States and Canada.

Our Readers Say



No Naval Ratio Worries Busy Model Maker

For the last two years, I have been a constant reader of your magazine and consider it to be excellent. I have followed the Model-of-the-Month page and now have to my credit models of the *Normandie* and U. S. S. *Saratoga*. I have written to you for two reasons. One is that you have Mr. Gommi prepare simplified plans of the new Cunarder *Queen Mary* for publication about the time the ship makes her maiden voyage. The other reason is to request that you have Mr. Gommi (he'll be a hard-worked man before I'm through) give us plans of representative ships from various navies which show the trend in naval construction. I would nominate the following: *Dunkerque*, French battleship; *Deutschland*, German battleship; *Minneapolis*, U. S. battleship; *Nagato*, Japanese battleship; and *Courageous*, British aircraft carrier.—N.M., Winnepeg, Canada.

He'd Restore the Oil Drained From Nation's Cars

How about turning our crankcase drainings into useful automobile fuel instead of casting them into refuse barrels? Some garages, I know, use this waste oil for various purposes such as a lubricant for springs or as a fuel, when sprayed on pieces of old tires and burned in a heater. Computed on a basis of 25,000,000 pleasure cars in the United States, not to mention the trucks, tractors, busses, airplanes, launches, and motor cycles, I've estimated the annual drainage from automobile crankcases to be about 375,000,000 gallons of waste oil. Why not crack this flood of oil into the short-chained hydrocarbons and then polymerize these so that the oil may be sold and used again? Incidentally, a large amount of raw gasoline could be reclaimed directly from the oil simply by distillation, especially if a big percentage of the drivers in the country choke their cars as I do in Vermont's winter temperature.—H.L.C., Springfield, Vt.

Boy's Room Makes This Dad Cheer for More

I have been reading your magazine since 1922 so you can judge how highly I regard it. I have made many worth-while projects from plans and diagrams appearing in it, but nothing has appealed to me as much as the "Boy's Room" in the December number. It's great! May I suggest that you furnish working blueprints for this project? I know many dads like myself will want them. Also, would it be possible to induce Hi Sibley to design a sea chest and a combination desk and work bench to harmonize with the swell set of furniture already described?—L. de B., Millbrae, Calif.

Aye or No, Legislators Insist on Saying It

Reading the article, "Meet the Champion Inventors," in the January issue recalled to my mind the fate of Edison's first patented invention. It was an automatic vote recorder. When a vote was called for in any legislative body, the device, if used, would record the result of the balloting almost instantly because each legislator would be provided with buttons at his desk by which he could indicate his desired action and the individual and summarized ballots would be shown on a tabulating board mounted in a suitable position in the legislative hall. Edison, at the time a very young man, demonstrated his device to our Congressional bodies but they would have none of it. No, the Representatives, for instance, would rather sit around while the clerk droned out 435 names. And think of the time that would be saved at national political conventions by this device! —T.S.P., Washington, D. C.

They'd Float Through the Air With the Greatest of Ease

I always open the magazine, when first received, to Our Readers Say to learn what the readers are doing or thinking about. In the January number, G.R.B., of Flin Flon, Canada, presents an interesting problem involving the use of magnetic force to propel a rocket. In this field of physics, I have had a theory in mind for some time. I would like to know if the readers think it is feasible. It is this. One can pick up a pin with a small magnet and with larger magnets can lift heavy objects. If the magnet, for example, is powerful enough to lift the pin from the floor, thus counteracting the pull of the earth, the pin under the magnet's influence is weightless. If the lowering of the magnet could be regulated so that it could be stopped the instant its pull on the pin equaled that of the earth, then the pin would float midway between the floor and the magnet. There can be created, in other words, a zone where, for each specific mass, the pull of the magnet and the earth are the same. In such a zone, the object would be without weight. This principle, I believe, could be made practical in factories where large quantities of heavy objects made of ferrous metals are moved about.—W.H.B., Iowa Falls, Iowa.

He's Afraid Magazine Is Going to the Dogs—and Cats

For about twelve years, I have been a reader of your magazine. It is certainly a fine publication, but I wouldn't be an inventor if I said it was perfect. When I buy Popular Science Monthly I expect to read something about all the sciences, so why neglect the purely mental sciences such as psychology? If articles on such subjects were written by experts, I am sure they would prove more popular than the articles on dogs and cats that I have read in your magazine.—J.E.B., Quebec City, Canada.

Why the Foremost Are Sometimes Last

Some time ago I read with interest your answer to a question asking if the manner in which animals rise, on fore or hind legs first, is a characteristic common to each species (P.S.M., Oct. '35, p. 55). Recently I read a more detailed explanation of this family trait, offered by an English writer of scientific subjects. In tracing this hereditary peculiarity, the author points out that the ancestors of the horse lived in grassy country, somewhat like our early western prairies. Since these ancestors of the horse were no larger than rabbits, they had to raise their heads to look out over the grasses. As the grasses developed into taller forms, the horse evolved into a bigger species. Instinctively, it seems, horses always raised their heads above the grasses at any alarm and so that came to be the safe way for them to rise. The ancestors of cattle, the writer explains, in contrast, lived in an entirely different environment. These forebears, members of the deer family, lived in forests or on wooded land. When alarmed, these animals learned to keep their heads down—watching the enemy from underneath the tree branches. So it became a natural trait for their descendents to rise on their hind legs first.—S.Y., Covington, Ky.

Where Counting to One Hundred Is Good Advice

What is the compensation for spending your leisure moments over a period of eight or nine months making a decorative ship model when the first friend, to whom you pridefully exhibit your masterpiece, glances at it for a moment and then nonchalantly inquires, "Have you tried it in the water yet?"—C.M.S., Philadelphia, Pa.

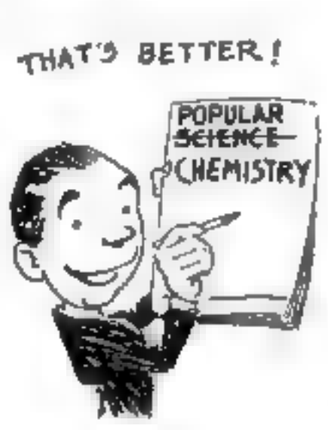
Sees Boon to Humanity In Dental Anesthetic

Hats off to Dr. Leroy Hartman, of Columbia University! When I read, in your last issue, of his achievement in robbing the dentist's drill of its terrors, I thought: "Here is a scientist who is really a benefactor of humanity." Instead of fiddling around with atoms or measuring the distance to some insignificant star, he has done something that will bring comfort to thousands of people every day. His bust ought to be placed in every dentist's waiting room, along with the year-old copies of monthly magazines. I can't say as much for another

discovery you reported recently—the gadget to silence the barber's shears. I may be very thick-skinned, but I was never annoyed by the clicking of shears in a barber shop. While science is working on the tonsorial parlors, why not do something to silence the barbers? —J.A.B., Flushing, N. Y.

From Fossil to Factory On This Reading Menu

While you have a splendid magazine, it, like all things, can be improved. Firstly, let Mr. Walling give us more articles on bacteriology; secondly, more adventures into the medical world with Dr. Frederic Damrau are in order; thirdly, articles on geology and paleontology would be welcome; fourthly, to the fine chemistry articles add some on quantitative analysis; lastly, I would like to see an article about the daily work that goes on in some large chemical research laboratory. I have, I believe, a pretty complete home laboratory which includes a library of scientific books. One large shelf is reserved for copies of Popular Science Monthly.—M.R.S., Winnepeg, Canada.



A Three-In-One Vote For the Cast Resins

You gave us a very fine article on the working of cast resins. The question was asked if the readers desired future articles on this subject. I, for one—and this includes my two sons—ask that there be more articles about resins. This new type of craftsmanship has much to draw interest and will be followed more extensively as knowledge of it spreads. We like the work and suggestions set forth in the articles and want additional ones. How about an article on the new phases of carving these plastics and the instruments to be used?—H.B.S., Newport, Ky.

Looks to P.S.M. so He Can Look Through His Telescope

Although I have taken your magazine only a year, I am greatly pleased with it. Many times it has proved to be an excellent source of reference. A few months ago, in Our Readers Say, a reader asked for an article on the making of mirrors for telescopes. I, too, would like to see some articles on the construction of astronomical instruments such as cameras and spectroscopes. I am building an eight-inch telescope and would appreciate an article telling how to make a suitable equatorial mounting and also a simple clock drive. —R.K.D., Dalton, Mass.

A Tug with Nothing Amiss From Keel to Truck

Have been buying your magazine for nearly five years and think it's "tops" just as it is, so I hope that some of the changes suggested by the "advisory council of would-be editors" found in Our Readers Say are not taken too seriously. It is my desire that, in the near future, Captain McCann be prevailed upon to give us a model of a seagoing tug with all the details from a dirty boiler room to a cuspidor in the wheelhouse; also a power plant for the model, as was done with the *Preston* Captain McCann can give us an authentic tug model, if anyone can.—R. La H., Owosso, Mich.

Amateur Chemist Says Let's Invade the Organic Field—

Of late, I've noticed that your articles on chemistry have been very childish. These articles, and in saying this I speak on behalf of a thousand or so amateur chemists, have a high educational value and excellent illustrations but they lack the advancement to make them interesting to the intermediate amateur chemist who has passed the age of baking soda and vinegar just to hear the pop. Why not publish something a little more advanced as suggested by J.O.S., Jr., of Middle Village, N. Y., in the December number? Here are my suggestions and they are offered on behalf of the many members of the Organic Chemist Correspondence Club: (1) the author, Raymond B. Wailes, is excellent; (2) get away from common everyday things. Suppose a new dye or antiseptic were discovered and prepared. P.S.M. could give up-to-the-minute laboratory experiments to illustrate its uses. (3) give organic chemistry a trial, including analysis, preparing commercial organic compounds, toxicology, and laboratory construction.—F.E.C., Newport, Vt.

She's Right at Home With Blueprints

Miss M.S.L., of Monrovia, Calif., stated in her letter that women have little mechanical ability. I don't agree with her. I've studied blueprints for years and have had little trouble constructing things from such plans. Also, I have built, among other items, a motor of my own design. Maybe I'm blessed with more mechanical ability than most women but I believe if Miss M.S.L. would study mechanical devices long and hard enough, she would discover that she, too, had more than a little mechanical ability.—(Miss) M.W., Arkadelphia, Ark.

How Can Reader Make These Wax-Plaster Molds?

I hope some one will write an article in your magazine about the method of making wax patterns which can be embedded in soft plaster of Paris. When the plaster has hardened, the wax pattern is melted and removed. The resulting form or mold can then be filled with a molten metal and in this manner artistic and useful castings are made.—R.P., Nogales, Ariz.

Wants His Stopped Watch To Tell Time

Will you please submit the following question to the readers of the magazine? It is generally known that the points of the compass can be determined from a watch if the watch is laid flat on your hand with the hour hand pointing toward the sun, that is, so that the shadow of the hour hand lies directly beneath it. Then, halfway between the minute hand and twelve on the dial is south. What I would like to know is, if your watch has stopped and you know the compass directions, can the procedure be reversed so that you can set your watch to the true time?—R.H.L., Denver, Colo.

Mechanical Smeller Needed For Those With Faulty Noses

It is surprising to me that no practical, inexpensive device, comparable to glasses for those with poor eyesight, has been developed for persons with a deficient sense of smell. That this field has been neglected was brought to my mind recently when I read that a saleswoman girl employed by a perfume-retailing firm had disclosed that she had lost her ability to distinguish various perfume odors. Maybe this thought may start some clever reader on the road to an invention that should be worth a fortune.—J.N., Jr., Java Village, N. Y.

Inverts December's Cover And Sees Strange Monster

Your cover, I see, has evolved into a puzzle picture. I noticed that the cover of the December number, when inverted, bears a remarkable resemblance to some prehistoric monster or imaginary robot-bird. I do not know if your artist produced this fearsome creature by accident or intention but now that it is here, it seems to me, we must make the best of the situation. It's a tough-looking bird so I guess we had better make some friendly signs or gestures. Friend or enemy, it certainly should have a name. The most appropriate name, I think, would be some sort of an upside down cognomen. I suggest "Ularsciencepop"—of the machine age.—D.E.P., Chicago, Ill.

Does a Little Globe Trotting On One-Tube Set

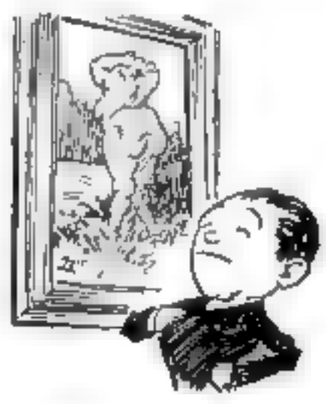
Well, I finally built the one-tube set described in the June, 1934, issue. And was I surprised! The first night I had it working I picked up DJC, Berlin, Germany, and since then I have logged over 150 foreign and domestic amateur stations. Among these are such stations as GSC, London, England, HJ1ABB, Barranquilla, Colombia, YU2RC, Caracas, Venezuela, W8XAL, Cincinnati, Ohio, and W2XAD, Schenectady, New York. I want to express my thanks to P.S.M. and let you know that I think the magazine is a good one.—R.C., Nutley, N. J.

Transpacific Air Mail Looks Good to New Zealander

As a reader of long standing, I look forward each month to seeing the Home Workshop section. I have a go at some of your suggestions but we, in New Zealand, can't get materials and workshop appliances as easily as you can in America. When available, they are usually expensive. I have been wondering if you could give us an article on how to make a small lacquer-spraying outfit, suitable for finishing household ornaments and furniture. It will be a wonderful help to us in this part of the world when the Pan-American Airways have their new service in effect. No longer will we need to wait two and a half months for a return mail from your country.—D.G.L., Hamilton, New Zealand.

Four-Pigment Palette Recalls Artist Who Used No White

I noted the letter of F.O.F., of Newark, N.J., relative to the fact that Dr. Herbert E. Ives uses only three color pigments in his art work. Anders Zorn, as many know, used no white on his palette for in the technique of his art he left the high lights of his canvas blank. I know, for I am lucky enough to have one of his paintings. Zorn, it seems, relied upon his base filler to supply the "fourth color" (or contrast) to his work.—V.S.W., Minneapolis, Minn.



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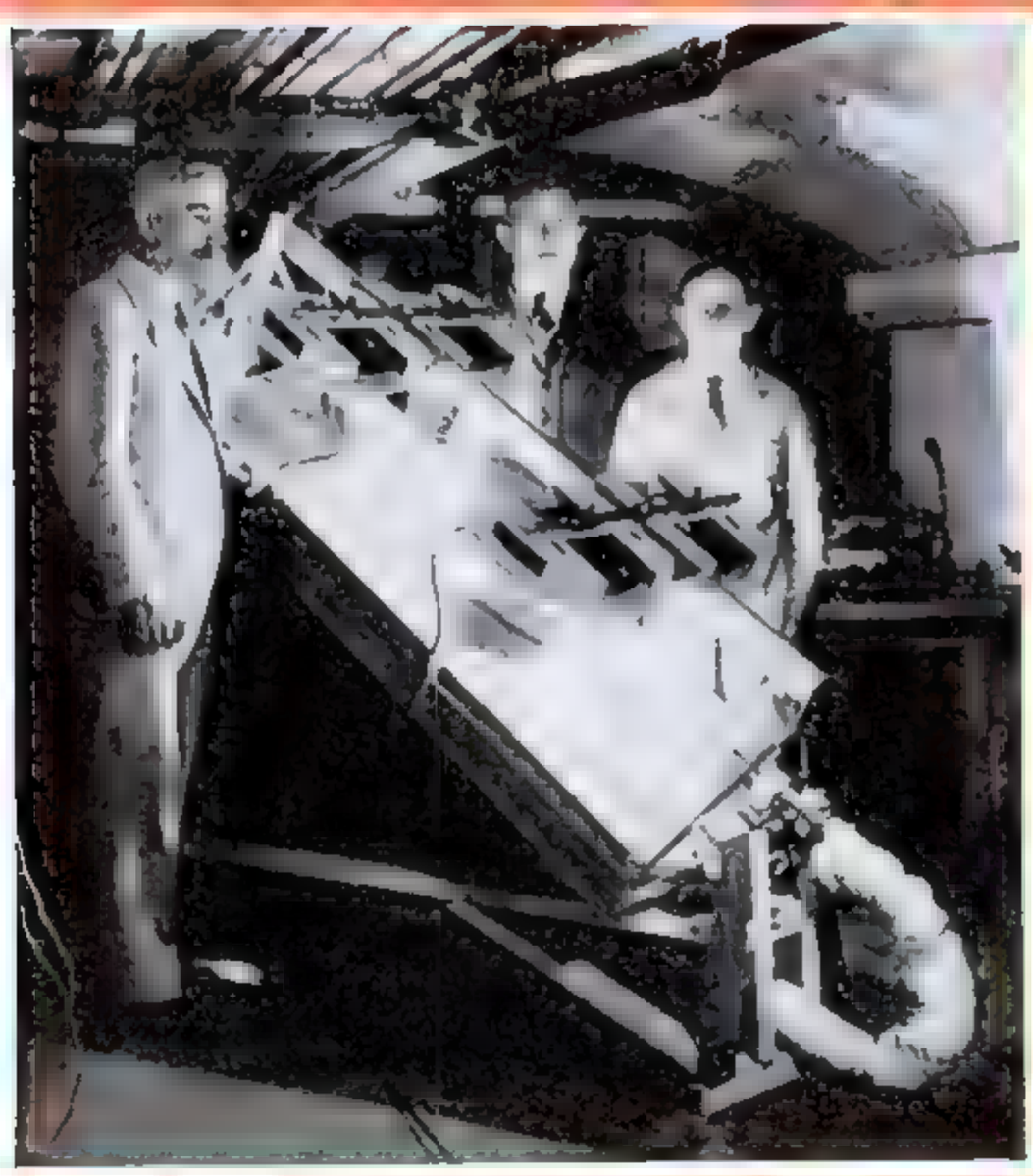
POPULAR SCIENCE Monthly

MARCH 1936 VOL. 128 No. 3

RAYMOND J. BROWN, Editor

A Challenge to Inventors . . .



With solar engines like the one being demonstrated here by Dr. C. G Abbot, men may harness the vast energy now going to waste in sunlight

By Edwin Teale

PROJECT your mind a hundred years into the future; imagine yourself in the year 2036. A century has passed since the 200-inch telescope mirror for the California Institute of Technology came from the annealing oven, since the *China Clipper* spanned the Pacific on its first flight to the Orient. You look around. In ten decades, what has science accomplished?

Strange, shallow lakes, filled with chemicals and covered with glass, are turning sunlight into electric power. Underground pipes, radiating from coal centers like the threads of a vast steel cobweb, carry gaseous fuel to smokeless cities. Automobiles scoot along highways leaving no trail of carbon monoxide fumes. Midget radios, worn like watches in vest pockets, bring in programs and transmit messages. And television flashes world-wide news in natural colors.

Such may be the world of the year 2036, if research can solve but a few of the many problems that are now listed as the unfinished business of science

So amazing has been the progress of the last century—

MANY VITAL PROBLEMS STILL WAIT FOR SOLUTION

with its radio, its moving pictures, its automobile, its airplane, its advance in every field of experiment—that many people have the vague feeling that science is a worked-out mine, that most of the great inventions and discoveries have been made, that opportunities for discovery will be fewer in the future.

In 1933, a young engineering chemist from Yale University, Dr. C. C. Furnas, visited A Century of Progress Exposition at Chicago. Its acres of exhibits, showing the marvels of modern research, set him thinking. What was there left for science to do?

He returned home and began collecting material for a book upon the unfinished jobs of science. Called "The Next Hundred Years," it has just come from the press, published by Reynal and Hitchcock. A chart for future research, it points out blank pages in the book of science and undertakes to answer the question: What lies ahead for scientists to achieve?

Consider a few of the simple things that Dr. Furnas feels are needed badly. We need a raincoat that will let out body moisture. We need paper as permanent as parchment. We need a metal for springs that will not fail with fatigue. Malleable glass and true artificial silk, without the defects of rayon; cloth that repels moths without having a disagreeable odor, and artificial teeth as good as natural ones are other common wants that science has yet to satisfy.

Newspapers that will not deteriorate, road surfaces that will last a century, roofs that never leak, rugs that won't show wear, knives that will not dull; any of these would bring fame and fortune to the experimenter who could solve the problems involved.

In 1920, the average American traveled less than 800 miles a year by automobile and more than 400 by train. Today, he covers about 3,000 miles by automobile and less than 150 by train. Yet, with all its improvements, the modern automobile is so inefficient that, according to Dr. Furnas, it is able to obtain only one twelfth of the potential push in a gallon of gasoline. Three hundred million gallons of fuel a year are burned by inefficient motors idling at the curb. Twenty percent of the gases leave the exhaust unburned. If engineers can retrieve this lost energy, the performance of the average car will jump to forty-five or fifty miles on a gallon of fuel.

Reducing the deadly carbon monoxide fumes in the motor car's exhaust is another problem for science to tackle. The unburned gases coming from the cylinders are responsible. So, increasing efficiency and decreasing carbon monoxide go hand in hand.

THERE are 10,000 alloys. But, as Dr. Furnas points out, new ones are needed. By such combinations of metals, research may develop autos with an average life of 100,000 miles. And, rubber from the laboratory has many possibilities. The United States, alone, uses 500,000 tons of rubber a year, mostly in automobile tires. Yet, nobody in the world can state the exact characteristics which define rubber. Its chemical formula is $(C_5H_8)x$. The x is the unknown element, the mystery for science to solve.

At various times, synthetic rubbers have come from the laboratory. But they have always lacked something. The x remains in the formula. Investigation has revealed a curious fact. In natural rubber, the molecules are strung together like sausages with at least 700 links in a chain. In synthetic rubber, the chains are always short. What makes them long in the natural substance? Some unknown catalyzer—a chemical which by its presence causes other chemicals to combine without itself becoming part of the combination—is thought to hold the key to the secret.

In 1912, a German chemist arrived in New York with a synthetic-rubber tire which had survived a 1,000-mile road test. That, however, seemed to be its best possible performance. One synthetic rubber has been placed on the American market by a Delaware concern. It can be vulcanized without the addition of sulphur, which is always required with the natural product. But, it has a bad odor which chemists cannot eliminate. So the problem of artificial rubber is still an open field of infinite possibilities.

Turn to the subject of power.

With the coal, wood, and oil resources of the world diminishing, Dr. Furnas declares, new sources of power are of increasing importance. Can science release the energy of the atom? Can it tap the endless power of the sun? Here is a realm of research studded with opportunities.

The sunlight striking a roof with an area of about ten square feet represents a horsepower of energy—enough to keep all the electric appliances in an average home running continuously during the day. By harnessing the sunlight flooding the 200 square miles of the Mohave Desert, we could supply the power demands of the whole United States. And, if we could capture and store the energy of one minute's sunshine striking the surface of the earth, we could take care of both the heat and power needs of the world for a solid year!

Yet, so far, this never-ending flood of power remains untouched. How to harness it is a vital problem of the future. Will it be accomplished by solar furnaces, by thermocouples, by photo-electric cells, or by chemicals? The world of 2036 may know the answer.

In the past, boilers heated by reflected sunshine have proved of low efficiency. Thermocouples, instruments formed of two wires of different metals joined together so they produce feeble currents of electricity when heated, have been tried. Once, in a laboratory, a battery of thermocouples ran a toy motor when struck by the rays of the sub. But the output of current is so small, the idea has no present practical value.

Photo-electric cells are little, if any, better. At Schenectady, N. Y., General Electric engineers have developed a giant cell with fifteen square feet of light-sensitive surface. Set in the sunshine, the cell developed one fly-power — in other words, about four ten-millionths of a horsepower.

If, Dr. Furnas points out, the next hundred years can solve two chemical prob-

Safer and more effective anesthetics are among the goals still to be achieved by science. Here, attendants are using an improved apparatus which purifies the gas for use again

ENERGY FROM PLANT FIBER. Harold Ohlgren and William Mahle, college students, telling how they developed a cheap commercial gas for heating and lighting from stalks of clover

lems, a dramatic new approach to turning sunlight into power will be possible.

Great, shallow lakes held in concrete reservoirs and covered with glass to keep out wind-blown dust, will hold water and carbon dioxide and an unknown catalyzer. The sunlight passing through the solution will cause the water and carbon dioxide to combine into formaldehyde, at the same time absorbing large amounts of solar energy. Piped to thousands of cells, the formaldehyde solution will pass over electrodes in the electrolysis room and a second, now unknown catalyzer, and the proper electrolyte will oxidize the solution and give back the water and original carbon dioxide, together with electrical energy. Only the discovery of two catalyzers stands between that dream and its realization.

Another field of research in connection with power is the use of plant fiber for fuel as a substitute for coal. Each year, fifty times as much energy is stored in plants as

This "mechanical brain," which performs mathematical feats beyond the power of the human mind, may be the prototype of amazing devices that will save mental as well as physical labor

Many rare or exotic natural products will be re-created artificially in the laboratory. Above, an experimenter is sampling a synthetic coffee that comes from a test tube

Secrets of light and color will be revealed by instruments like this. It analyzes light transmitted or reflected into it

the world uses. Sugar cane, if permitted to mature, would produce fifty tons of fuel to the acre, and ensilage corn as much as five tons. Special researches in breeding plants for fuel might increase the production tenfold. Probably, the plant-fiber fuel would be pulverized and burned in the manner of powdered coal.

In connection with coal, a development for the future is the elimination of smoke from cities. Autopsy surgeons, Dr. Furnas states, can distinguish present-day city dwellers from people who live in the country by the accumulation of soot in the lungs. In the Chicago district alone about 2,500 tons of sulphurous acid fall on the inhabitants during an average day. This product of coal smoke hastens the decomposition of shirts, shoes, dresses, and carpets, dulls the finish on automobiles, and ruins the paint on houses. The average laundry bill in the district is sixty percent higher than in other cities where less coal is burned. By turning coal into gas at the mine and piping it under high pressure to distant cities, centers of population can be made virtually smokeless.

Similarly, according to Dr. Furnas, if research can produce cables that offer less resistance to the passage of current, electricity can be sent from hydroelectric centers to all parts of the country. Fifty years ago, an English scientist named Osborne Reynolds prepared a report which proved, to his own satisfaction, that electricity never could be sent over wires for more than a few miles. In place of transmission lines, he proposed rope drives running from pulley to pulley as a means of carrying power across country. Modern high-tension lines, extending more than 200 miles, prove Reynolds was wrong. Multiplying the distance over which current can be carried profitably is a problem for the future to solve.

Every twenty-four hours, the average man breathes in one fifth his own mass in air. And, once in fifty days, he consumes his weight in food. Cleansing the air of germs and dirt and developing new and better foods offer other opportunities for research. Disease-proof plants and super-animals may be a by-product of this work.

Of eight vitamins which have been isolated in foods, Dr. Furnas states, only two are now produced synthetically in the laboratory. And, only two of the dozen most essential hormones—those stimulating chemical substances manufactured by the organs of the body—are reproduced by test-tube methods. Here, again, the experimental chemist has an open field.

Common colds cost Americans $2,000,000,000 a year. Their cause still baffles science. No one has seen the minute organisms believed to be responsible. Eliminating this most common form of illness is one of the objectives of the future.

When you read an average-size book, your eyes travel along a mile of type. Better lights and more easily read printing are needed to save straining the eyes on their yearly journey along the miles of black letters printed on white paper.

Artificial fireflies, producing cold light by chemical reaction, form an intriguing possibility for future development in the field of illumination. In 1913, one scientist isolated the active constituent of a firefly's light, a chemical called luciferin. By placing it in water together with another substance, luciferase, and letting hydrogen and oxygen bubble through, he produced a pleasing glow. But no practical application of the discovery has yet been made.

Dr. Furnas visions future firefly lamps of the laboratory as resembling great pincushions surmounting bowls filled with a sugar-reducing solution. As the air circulates over the spongy mass, which is coated with luciferin, wicks drain the reducing liquid to the surface and chemical reaction produces the cold light. Fans, driving more air over the lamp, can increase its brightness. Such may be the cold-light lamps of the future.

Turning to the seas, which cover approximately three fourths of the earth's surface, Dr. Furnas sees boundless possibilities for discovery. Mining the ocean has just begun. On the North Carolina seacoast, a plant is extracting half a *(Continued on page 87)*

Magic Eye Reveals

Operated like an ordinary spotlight, the portable mercury-vapor lamp at the left is being used to test rock formations for fluorescent minerals. The drawing below shows how mercury vapor, released from ore by the flame of a blowtorch, casts a telltale shadow on a screen coated with willemite, which glows in the ultra-violet light from a mercury-vapor lamp

By STERLING GLEASON

MAGIC black light that makes rock appear to burn with living fire, now is being used to trace lost ore veins, to sort metal-bearing materials, and to detect the presence of valuable minerals in what seem to be merely pieces of dirty, worthless rock.

The science of mining has advanced far beyond the knowledge of the old-timer who groped in the darkness of a tunnel with only a carbide lamp and a smattering of mining lore to aid him. Cameras, microscopes, and galvanometers have replaced the familiar test tube, retort, and assaying furnace of the chemist, revealing in a few moments the presence of dozens of substances formerly detected only through days of arduous, complicated research.

Tracking metals by invisible "smoke" given off from heated ore, and reading "fingerprints" from pin-point nuggets of gold, are among the uncanny methods of the modern assayer's laboratory. And in the darkness of the mine itself, new "eyes," radiating black light, lead the way to elusive ore bodies that the naked eye fails to detect.

Deep in a Nevada mine, a man recently stepped out of the skip, carrying a small wooden box with a black tube attached to its front. Trailing a cable, he walked down the tunnel to where it ended against a blank wall. An electric arc sputtered as he turned a switch and adjusted a knob. Then he pointed the instrument's muzzle toward the blank rock wall and turned it back and forth like a spotlight.

Suddenly, a ghostly blue glow appeared on the rock's face, as invisible rays from the arc fell upon a stringer of ore. It was tungsten, in a formation indistinguishable by the naked eye from ordinary rock. But under ultra-violet rays, it fluoresced weirdly, and, as the beam flashed back and forth, the vein stood out from the common rock, glowing as if from fire within. Miners needed only to drill blast holes at the right points to break down large masses of ore with but slight disturbance of the barren rock.

Up until a short time ago, physicists knew of only some thirty minerals that glowed when exposed to the rays of the iron arc. But before a recent meeting of mining men at Bishop, Calif., C. D. Woodhouse, of the Champion Sillimanite Company, unfolded a host of fascinating possibilities opened up by recent research. More than a hundred minerals and certain oils, glasses, and paints as well, now have been classified with reference to this property. Among the more common minerals that fluoresce are some forms of zinc, tungsten, calcite, titanium, sillimanite, and corundum. Some, like scheelite, glow a brilliant blue, while willemite shows green and calcite appears brightly red and pink. Gold and silver do not seem to react to ultra-violet light.

The iron arc is simply an electric arc with iron electrodes, and operates on commercial voltages at about the same cost as a medium-size electric-light bulb. A tube acts as a shield to protect the eyes and to direct the rays in spotlight fashion.

Similar in action is the quartz lamp, in which mercury vapor, heated in an electric arc, yields ultra-violet light. Weighing only ten ounces, this instrument in its molded

Below, another magic eye that aids the prospector. It is the iron arc, using iron instead of carbon electrodes, and its ray causes many hidden minerals to glow

Hidden Mineral Treasures

Scientific Prospectors Use Strange New Instruments To Make Rocks Glow with Weird Light, Disclosing Presence Of Ore Veins that Contain Rare and Valuable Substances

Dr. John Herman, Los Angeles chemist and metallurgist, with a huge spectrograph which spreads a spectrum image into a fan-like pattern. A photographic film, traveling on a semicircular track, may be moved to explore any section of the spectrum

plastic case looks like a small spotlight, and its beam may be directed here and there like a hand flash light.

At a Mills City, Nev., mine, portable sets are made up and carried to the face of the tunnel, where the glow of the fluorescent minerals tells the miner where the values lie, thus saving the removal and handling of tons of worthless rock. Owners of a Randsburg, Calif., tungsten mine are planning to explore abandoned tunnels, using the ultra-violet "eye" to lead them to overlooked scheelite formations which may bear commercial values.

Held in a flame, mercury ore gives off vapor that casts a shadow on the screen. Metallic mercury in the beaker gives vapor without heat

The polarigraph, an extremely sensitive electric instrument which assays ores and reveals the presence of elements in minute quantities

In the future, predicts Woodhouse, certain types of ore may be sorted in the dark, with the iron arc, suspended over the sorter belt, causing each individual rock to tell its secret. Heretofore, barren material has been picked out by hand, many valuable chunks of ore thus escaping the vigilant eye of the sorter.

In a room at the laboratories of Dr. John Herman, Los Angeles, Calif., chemist, I recently saw another miracle of the modern art of ore seeking. A mercury-vapor-arc bulb lay on the floor, directing its purplish rays against a screen which glowed with a green radiance as the ultra-violet light struck the willemite with which it was coated. In a small glass beaker Dr. Herman held a few cubic centimeters of liquid mercury. As he thrust it into the beam, its shadow loomed dark against the willemite screen, and from it, a moving cloud rose like steam from a teakettle. It was a cloud of mercury vapor, escaping invisibly to the naked eye. The evaporation was infinitely slow—so slow, in fact, that a flask of mercury, if left uncorked centuries ago in the tomb of King Tut, might be taken out now almost intact. Nevertheless, under the intense light of the mercury arc, the vapor absorbed light as no other substance would do.

For the beaker of liquid mercury, Dr. Herman then substituted a piece of mercury ore, holding it in the flame of an alcohol lamp. A dense, smokelike cloud cast a murky shadow upon the fluorescent screen, although, to the eye, the "smoke" itself was invisible.

This simple test, discovered by Dr. Leighton of Pomona College, Claremont, Calif., instantly reveals the presence of mercury in ore, provided a mercury-vapor lamp is used as a source of the "black light." The intense mercury line in the spectrum of this lamp is the ray which betrays the shadowing presence of the mercury atoms in the vapor given off by the heated ore.

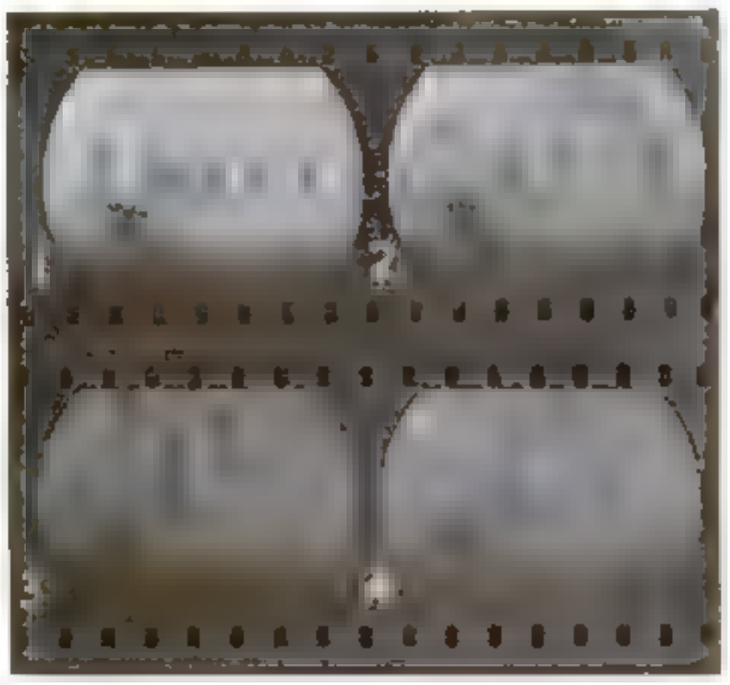
By setting up a willemite screen and mercury lamp in a mine tunnel, a prospector might trace elusive deposits of mercury-bearing ore, simply by running a blowtorch over the surface of the rock. Should a vein be encountered, it would betray its presence by giving off a cloud of invisible "smoke" that would show as a telltale dark shadow upon the screen.

Sturdy, simple, and foolproof, the ultra-violet arc in its portable case is the only one of science's latest magic-ray machines which can safely be taken into the mine itself, amid busy workmen and the hazards of falling rock and exploding dynamite. In Dr. Herman's laboratories are housed instruments with uncanny powers of probing into mineralogical mysteries. The spectrum is vastly expanded into a huge fan by a giant spectograph, with a large semicircular track which permits a photographic film to be moved to explore any part of the spectrum, giving a "close-up" picture of the composition of an unknown ore sample (P.S.M., Feb. '36, p. 29). A few grains of powdered rock, placed in a *(Continued on page 109)*

MICROSCOPE WHIRLS TINY CELLS APART

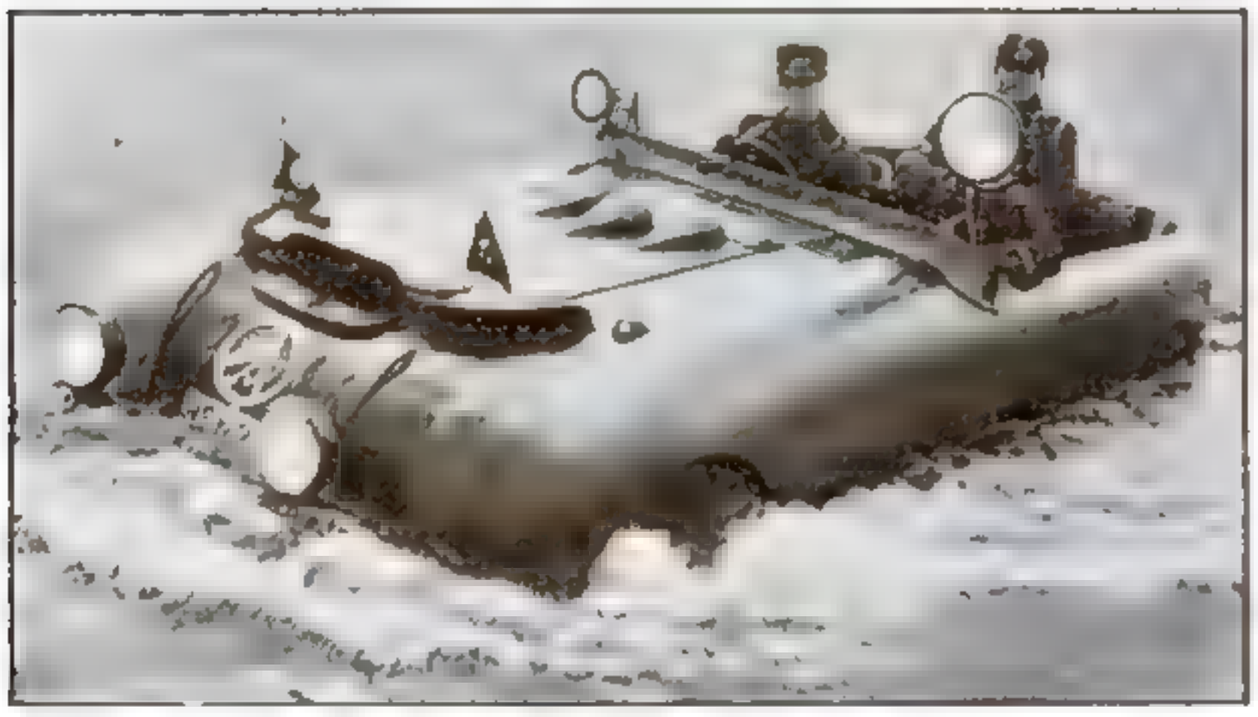
The centrifuge microscope in use. The photographs at the right show successive stages in the breaking up of sea-urchin eggs

WHILE an observer watches the process, the tiny cells of which living matter is constituted may now be whirled to destruction in a remarkable new research instrument called the centrifuge microscope. Material for study is placed in a small glass chamber, rotated at speeds up to 10,000 revolutions a minute, and illuminated by a momentary flash of light at each revolution. Through a microscope eyepiece, an observer can see the cells gradually giving way under the terrific centrifugal force, thus learning new facts about life processes. Photographic records may also be made.



NEW MASK IS GUARD AGAINST LEAD DUST

TO GUARD workers against inhaling particles of lead, considered one of the most dangerous of industrial dusts, a mask of new design has been introduced. By inhaling through a filter bag, which has a sufficiently large area to avoid interference with easy respiration, the user is protected against lead dust formed in certain industrial processes.



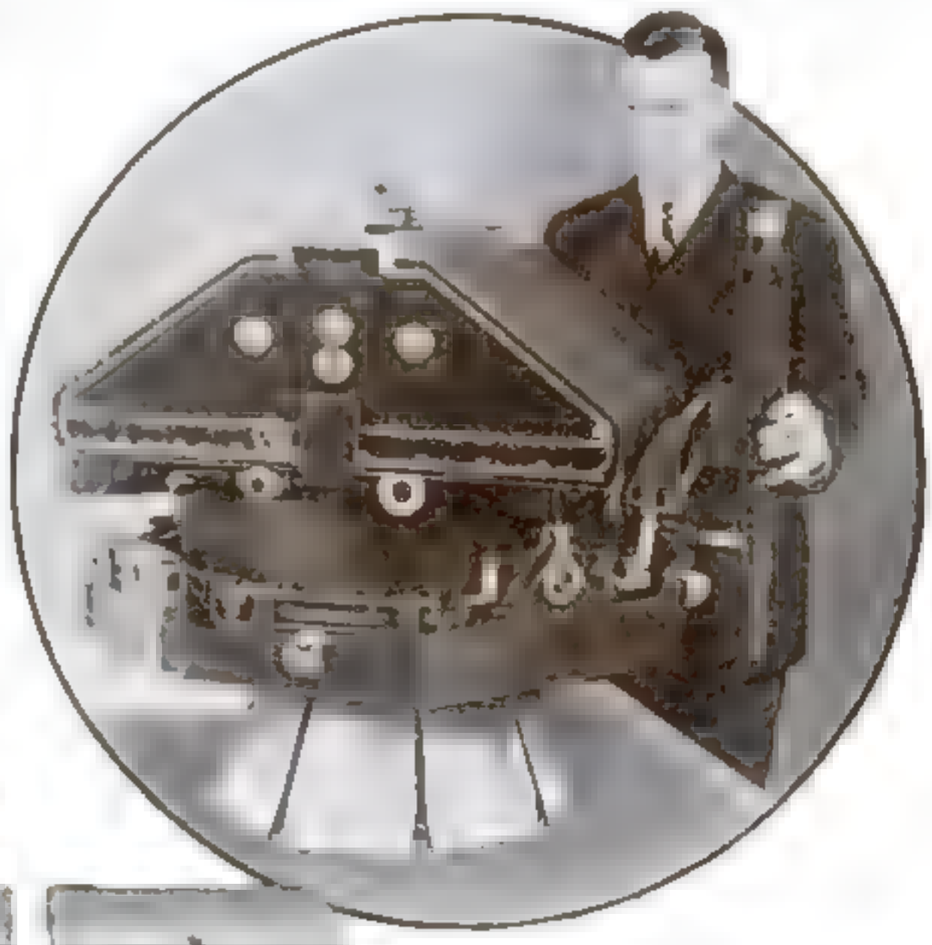
A new German land-and-water automobile undergoing tests. The car, which can do a mile and a half a minute on land, may have great military value

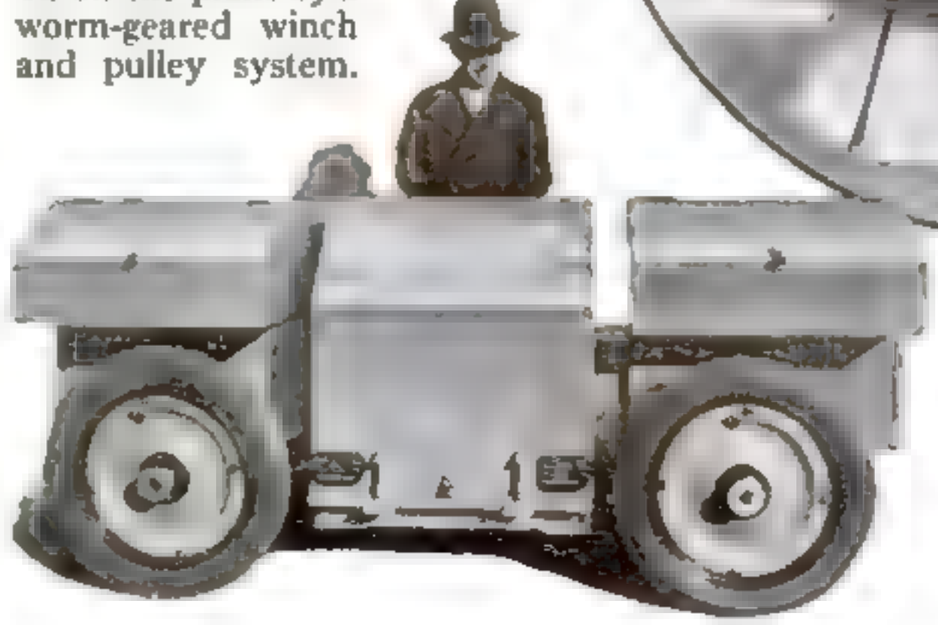
FAST AMPHIBIAN AUTO TESTED

CAPABLE of making ninety miles an hour on land and fifteen miles an hour in the water, a speedy amphibian automobile constructed by an inventor of Darmstadt, Germany, recently demonstrated its seaworthiness in trials on Lake Muggel, near Berlin. Its possible application to military purposes is foreseen, since vehicles of this type would facilitate the rapid movement of troops across terrain of varied character. The roomy body of the new machine, which is made water-tight to provide buoyancy in navigating a stream or lake, provides accommodation for four passengers.

AIR CAMERA SNAPS 600 SQUARE MILES

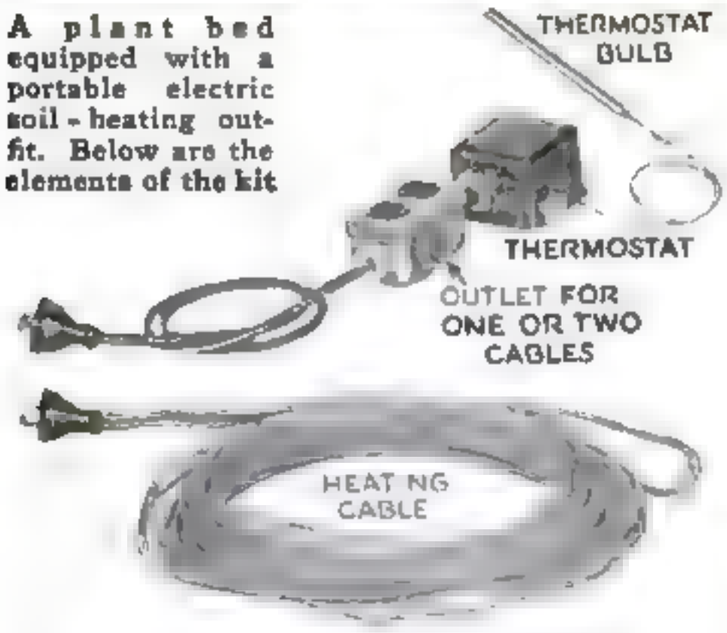
DESIGNED for mapping from a higher altitude than has ever before been practical with multi-lens equipment, a giant nine-lens camera just completed for the U. S. Coast and Geodetic Survey embodies several radical innovations in aerial photography. Aerial surveys at a height of 30,000 feet, where the air is less bumpy than at lower levels, and where better results will therefore be obtained, are made possible by the 8¼-in. focal length of the lenses, which is two inches longer than has hitherto been considered possible in a multi-lens camera. Another new departure is the use of aluminum-coated mirrors, of astronomical type, to increase the coverage of the lenses. The nine exposures are made simultaneously upon a single sheet of film nearly two feet square, which is held flat by a suction plate, and form a composite picture covering a ground area of 600 square miles. A special pneumatic-tired cart, probably the largest "camera case" ever built, transports the instrument, extra films, tools, and other accessories to and from the plane. The camera is loaded on the plane by a worm-geared winch and pulley system.





From an altitude of 30,000 feet, this mammoth aerial camera will map an area of 600 square miles at each exposure. At the left is the rolling "camera case" that takes it to and from an airplane

SMALL-SCALE GARDENERS GET SOIL-HEATING KIT

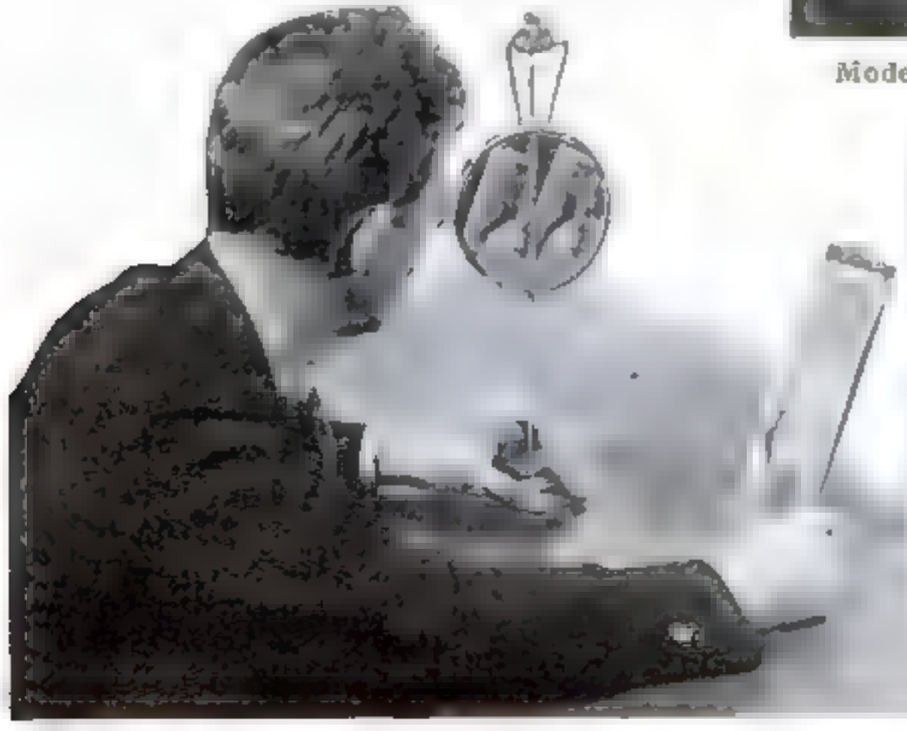


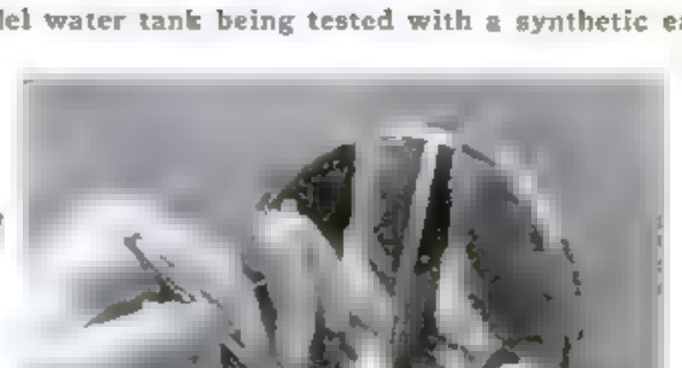
A plant bed equipped with a portable electric soil-heating outfit. Below are the elements of the kit

HOME gardeners are now offered a portable, electrical soil-heating kit for stimulating and controlling plant growth, enabling them to enjoy the same advantage as commercial florists and market gardeners employing large-scale installations of this type. Current from any convenient outlet heats a long, insulated resistance wire laid out in parallel lines beneath the surface of a plant bed. A thermostat keeps the temperature at any level desired.

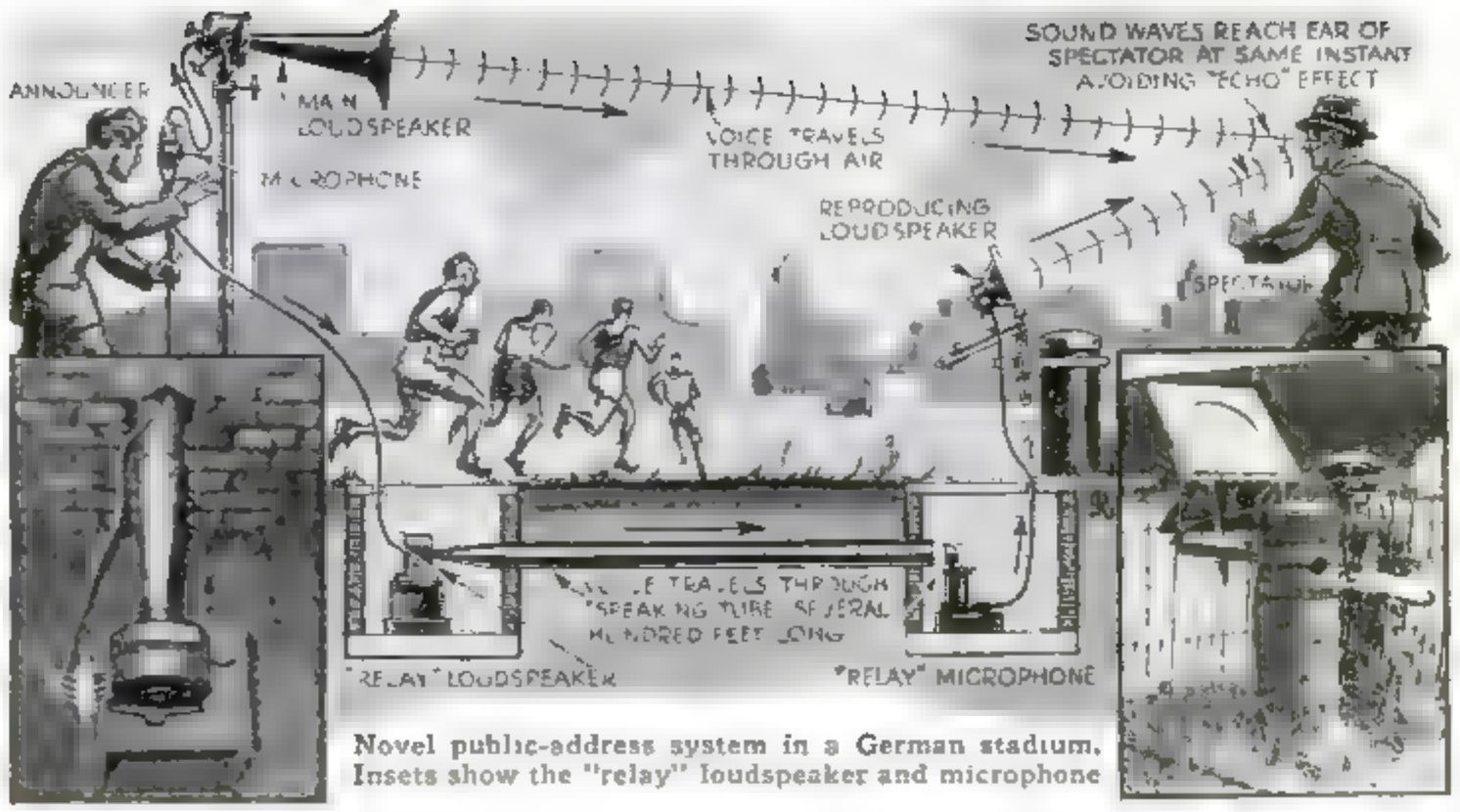
FLAT MIRRORS GIVE STEREOSCOPIC EFFECT

How "plane," or flat, mirrors can be used to produce a stereoscopic illusion giving ordinary pictures a three-dimensional effect, has been demonstrated by a Bridgeport, Conn., inventor. A flat mirror, split into two sections that are mounted at a slight angle to each other, is placed at a forty-five-degree angle to the user's line of vision and the picture is viewed through it. The reflected picture has an illusion of depth and enlargement.





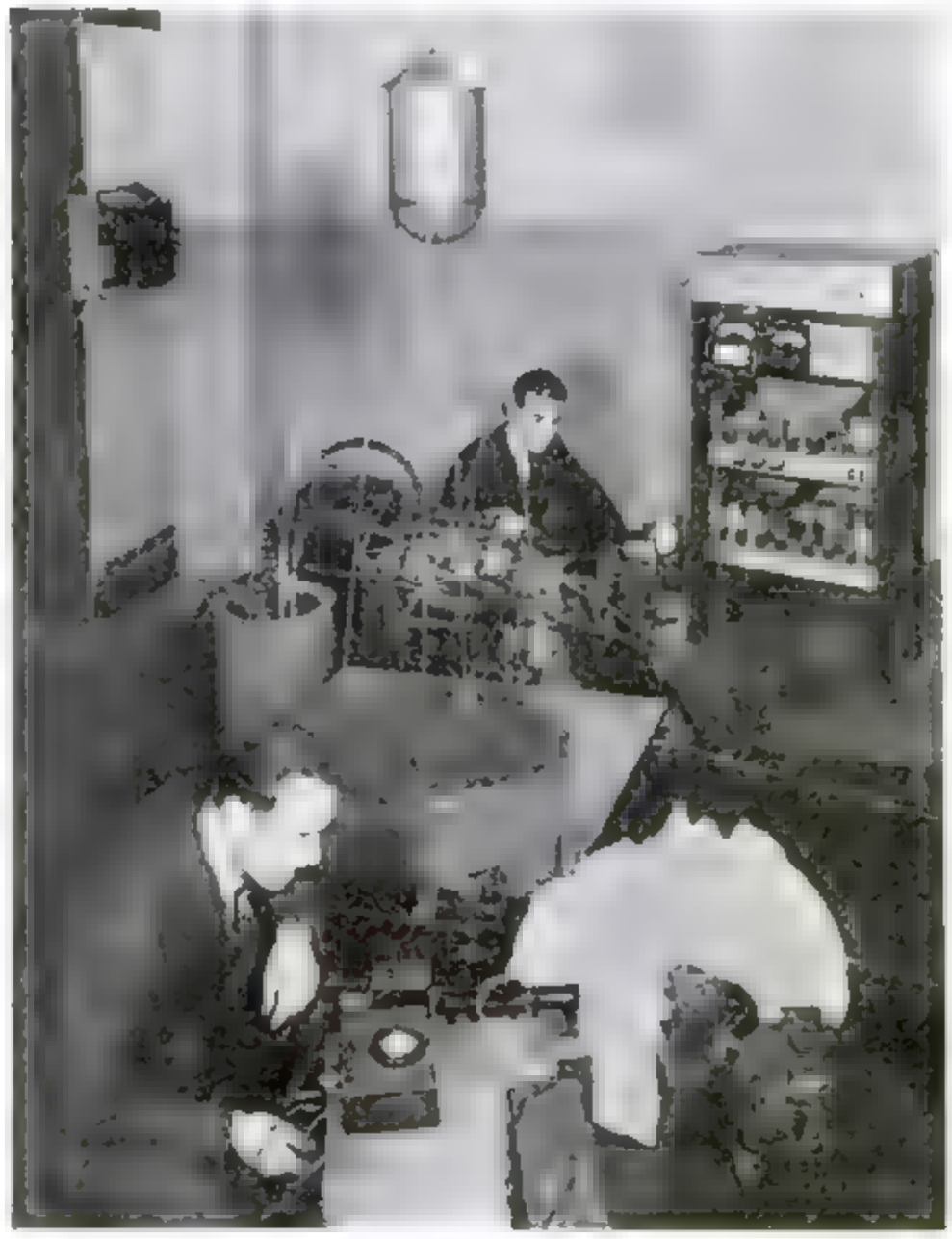
Mirror in two sections that gives stereoscopic effect. At left, device in use to supply depth to a picture



Novel public-address system in a German stadium. Insets show the "relay" loudspeaker and microphone

BURIED TUBES END LOUDSPEAKER ECHO

GERMAN engineers have just equipped a Berlin stadium with a novel public-address system, eliminating queer "echo" effects that often bother spectators listening to an announcer's voice coming from main and secondary loudspeakers at once. The disturbing "echo" occurs because sound waves travel much slower through the air than electric impulses through a wire. In the Berlin installation, one set of wires leads from the announcer's microphone to a powerful, centrally located loudspeaker, while another leads to a "relay" loudspeaker placed underground. Using speaking tubes for distribution, the plan eliminates "over-lapping" of sounds.



Model water tank being tested with a synthetic earthquake

SEISMOGRAPH RECORDS MAKE SYNTHETIC EARTHQUAKES

REPRODUCING the ups and downs of an actual seismograph record, a paper "cam" on a new testing mechanism devised at the Massachusetts Institute of Technology, Cambridge, Mass., can recreate in miniature any recorded earthquake of the past. The moving cam varies the amount of light reaching a photo-electric cell, and this in turn controls an oil piston that shakes a platform in an imitation earthquake. By employing model structures, the effects of different kinds of disturbances are being studied by engineers at the Institute. The jagged contours of the cam seen in the foreground of the photograph are an exact seismograph record of the Long Beach, Calif., earthquake of 1933.

KEY NUMBERS BREAK OFF FOR RECORD

DETACHABLE code numbers furnished with a new-type automobile key simplify the problem of obtaining a duplicate when the original is lost. The numbers, stamped on a projection which can be detached from the key and filed by the owner, give a locksmith the needed data.

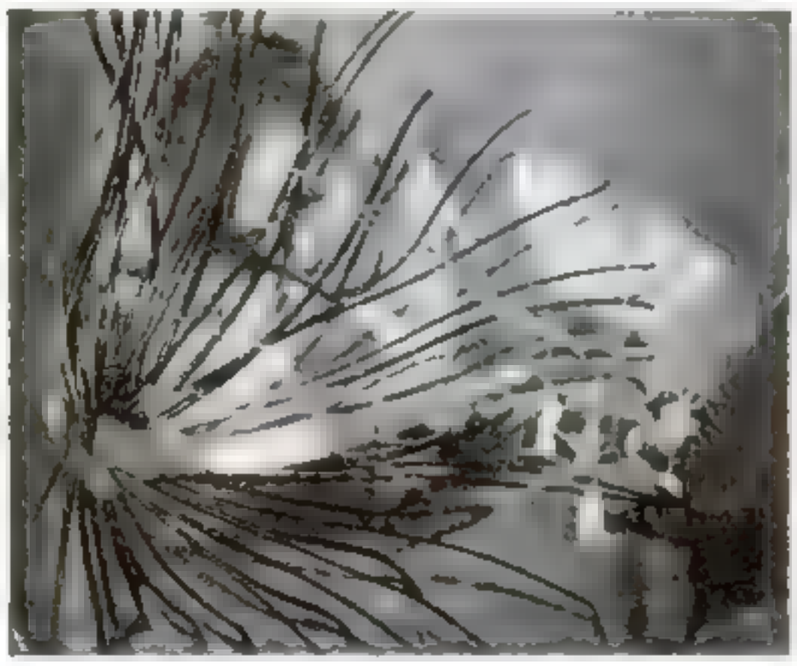
This mammoth wind indicator, installed at an English airport to give flyers direction for landing, is visible from 7,000 feet in the air

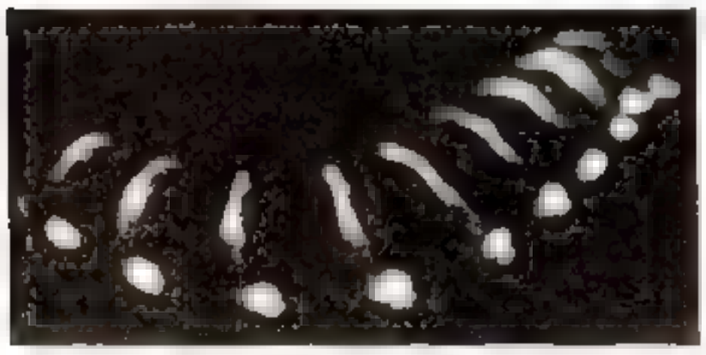
GIANT WEATHER VANE GUIDES PILOTS

A GIANT wind indicator of novel design erected at an English airport is sixty feet long and twenty-three feet wide. Made of galvanized steel, the huge rotating arrow points into the prevailing wind to show pilots, even when still at a high altitude, the direction of the ground wind and enables them to maneuver for landing. The mammoth pointer, looking like an oversize weather vane, is illuminated after dark and is said to be visible both day and night at altitudes up to 7,000 feet.

QUEER PHOTO SHOWS MAZE IN SEA CABLE

A TANGLED mass of interlocking wire strands screens the workman examining an undersea communication cable in the odd photograph reproduced at the right. The cable, containing telephone, telegraph, and radio-broadcasting circuits, is being laid across Bass Strait, a body of water separating the island of Tasmania from the mainland of Australia. Huge drums on the cable ship *Faraday* unwind the 160 nautical miles of cable of this type being laid along the ocean floor.



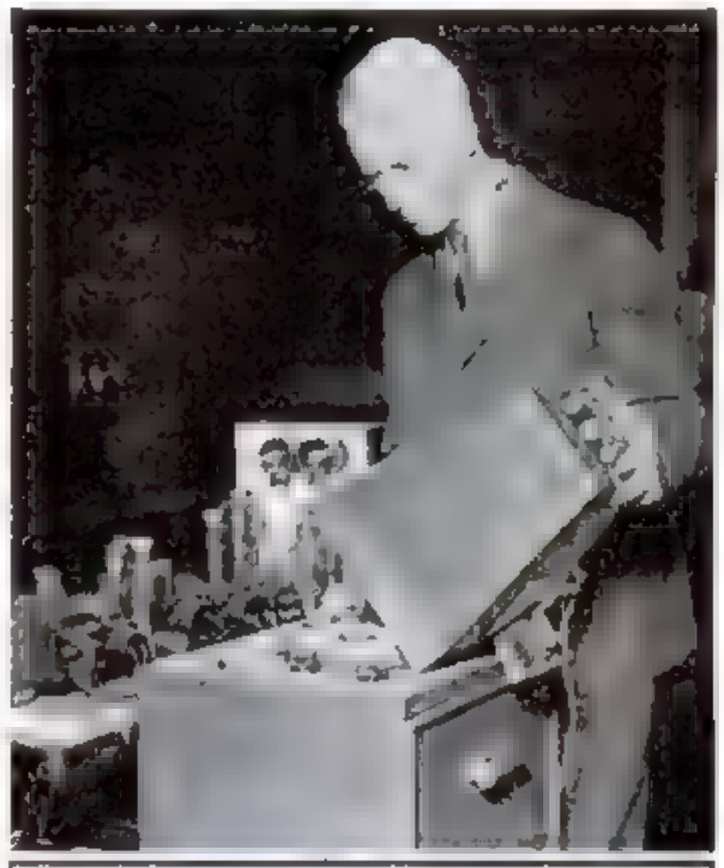


GLOWWORM PICTURED BY ITS OWN LIGHT

WHEN a camper found a specimen of a rare type of glowworm in the woods near Sumneytown, Pa., he took the odd photograph above. The picture was snapped in the darkness, with no light except that given off by the luminous insect itself. The greenish glow radiating from the body of the worm proved sufficient illumination to register upon the photographic film, with an exposure of thirty seconds.

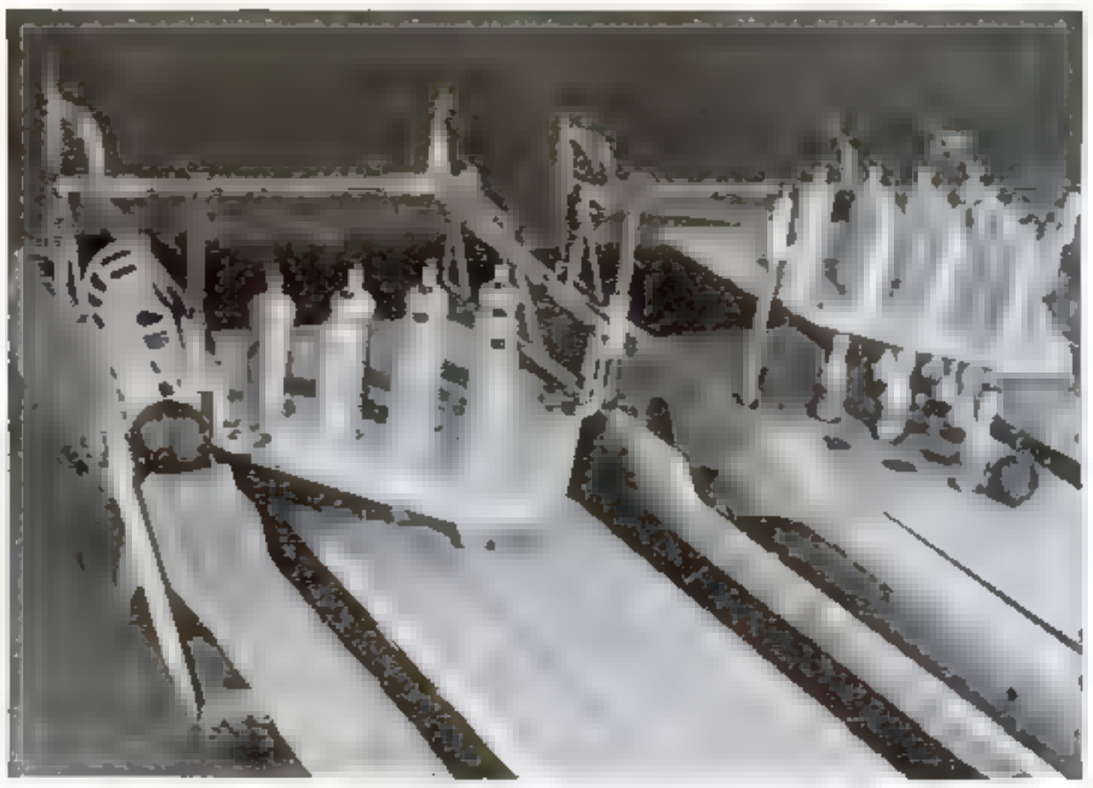
ODD DEVICE HAS MEMORY FOR PAST EVENTS

DESCRIBED as "quicker than lightning," a recording device perfected by General Electric Company engineers has the ability to remember and photograph past happenings. Called a pre-recording oscillograph, the machine translates the electrical impulses that travel along a power-transmission line into visible, wavy lines upon a screen. These lines fade out after a few millionths of a second. When a lightning flash strikes a power wire, however, causing a surge of current, a magnetic trigger automatically opens a camera shutter in time to record not only the effect of the bolt but also the unfaded record of the electrical impulses during a fraction of a second preceding it, for later study by engineers. The instrument will also register the failure of vacuum tubes.



Dr. A. W. Hull with pre-recording oscillograph, and sample record of a failure in a rectifier

MAGNETS HELP SET UP BOWLING PINS



AUTOMATIC bowling alleys recently introduced require no attendants. When a pin is struck, it is knocked loose from a magnetic plate embedded in the alley, permitting a spring to hoist it into a receptacle above. When the pins are to be set up again, an electric control lowers and raises the bank of receptacles, leaving the pins in place. The balls return automatically.

MICRO-RAY RADIO SAFEGUARDS FLYERS

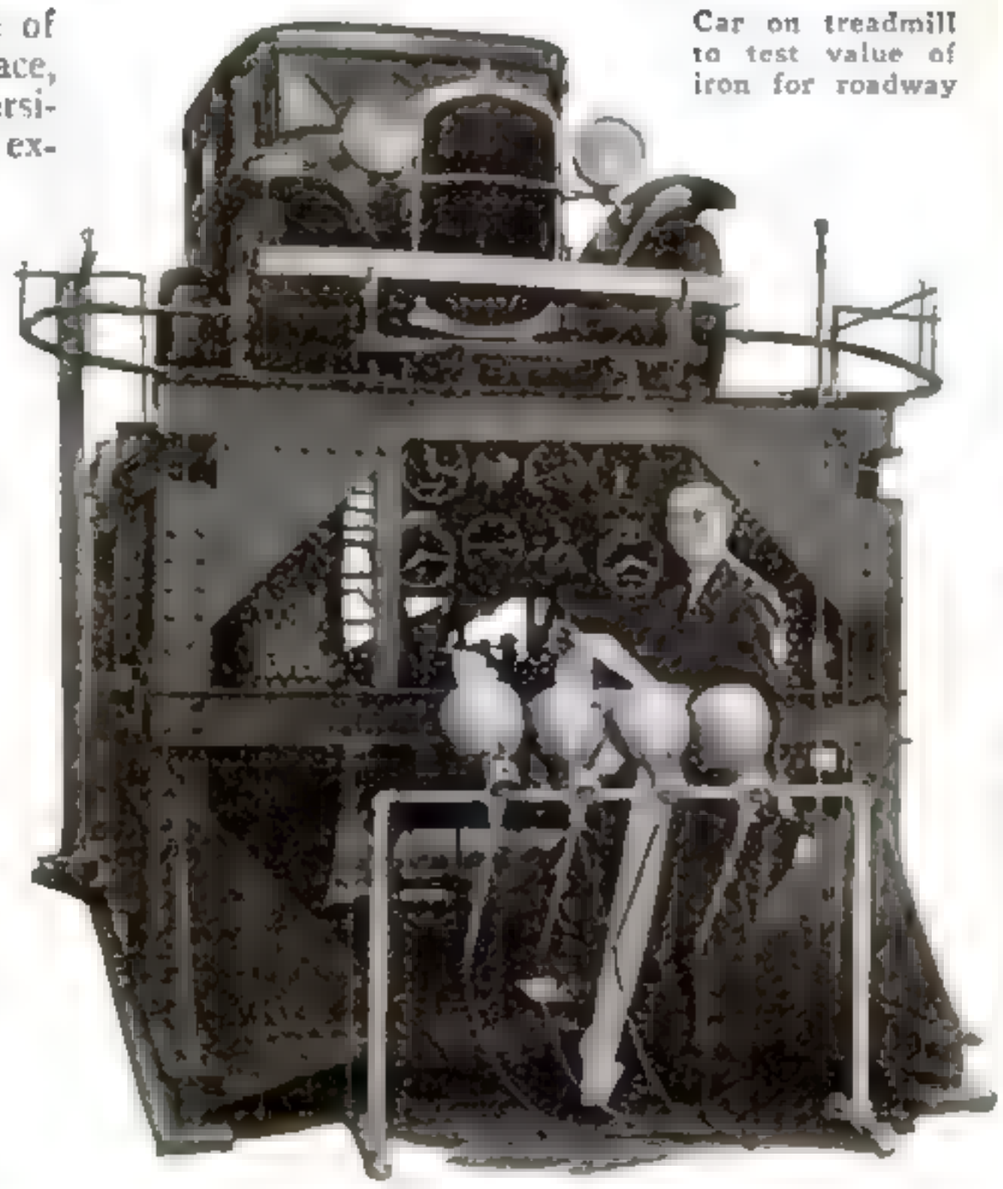
An operator sending a message across the English Channel by micro-ray radio to report the passing of a privately owned plane

USING less energy than is required to light a pocket flash light, and employing aerials less than an inch long, a micro-ray radio service across the English Channel aids private planes flying between England and France. By means of ingenious ten-foot aluminum reflectors, the tiny radio waves are concentrated like light into directional beams which carry the messages between the two stations, one at Lympne, England, the other at St. Inglevert, France, 35 miles away. Each plane passing overhead is reported across the channel, and when a machine is overdue, an immediate search is begun to rescue the pilot in case he has made a forced landing in the water. Wave lengths are "staggered," the wave being seventeen centimeters long for communication in one direction and seventeen and a half in the other. This enables simultaneous sending and receiving. The service is of special value for checking the passage of planes that are not equipped with radio.

Towers of the English station at Lympne. Reflectors concentrate the micro rays that transmit the messages

AUTO TREADMILL TESTS ROAD SURFACE

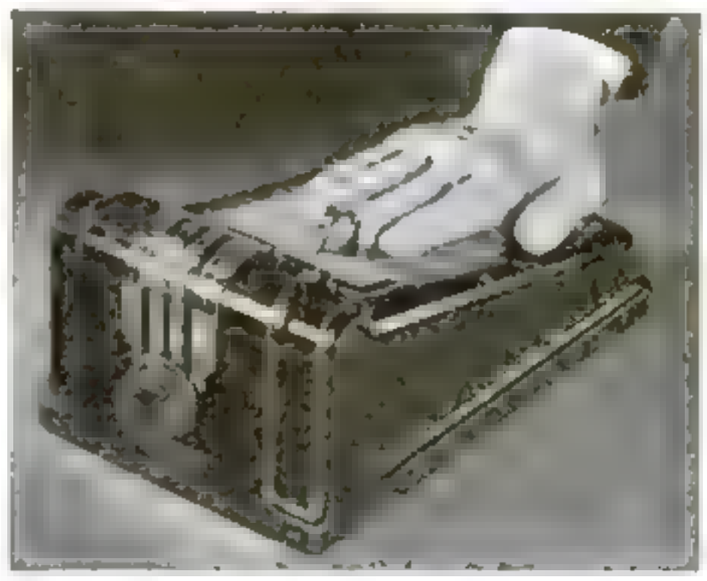
TO TEST the practical value of cast iron as a highway surface, Prof. E. W. Davis of the University of Minnesota is conducting experiments with an odd automobile treadmill. Actual road conditions are simulated by using a stationary auto whose tires rotate on a whirling artificial pavement formed by two 1,000-pound wheels of corrugated cast iron. The wheels, each six feet in diameter and one foot wide, are mounted in a riveted steel framework. Instruments record data pertinent to the tests.



Car on treadmill to test value of iron for roadway

LOTS OF HELIUM

A RECENT survey of the United States' helium supply shows ample reserves for years to come. This country holds a virtual monopoly of the valuable gas, which replaces inflammable hydrogen for filling airships and balloons.



HAND-MEASURING DEVICE RECORDS GLOVE SIZE

BY RECORDING automatically the length and width of a hand, a new instrument insures perfectly fitting gloves. The device is the invention of Prof. A. C. Davis, of Cornell University, Ithaca, N. Y. When a purchaser inserts his hand through an adjustable metal loop at the bottom of the instrument, the middle finger comes in contact with a movable button which is pushed forward a distance corresponding to the length of the customer's fingers, while the loop is tightened to measure the width of the hand.

Auto seat padded with new cushion material

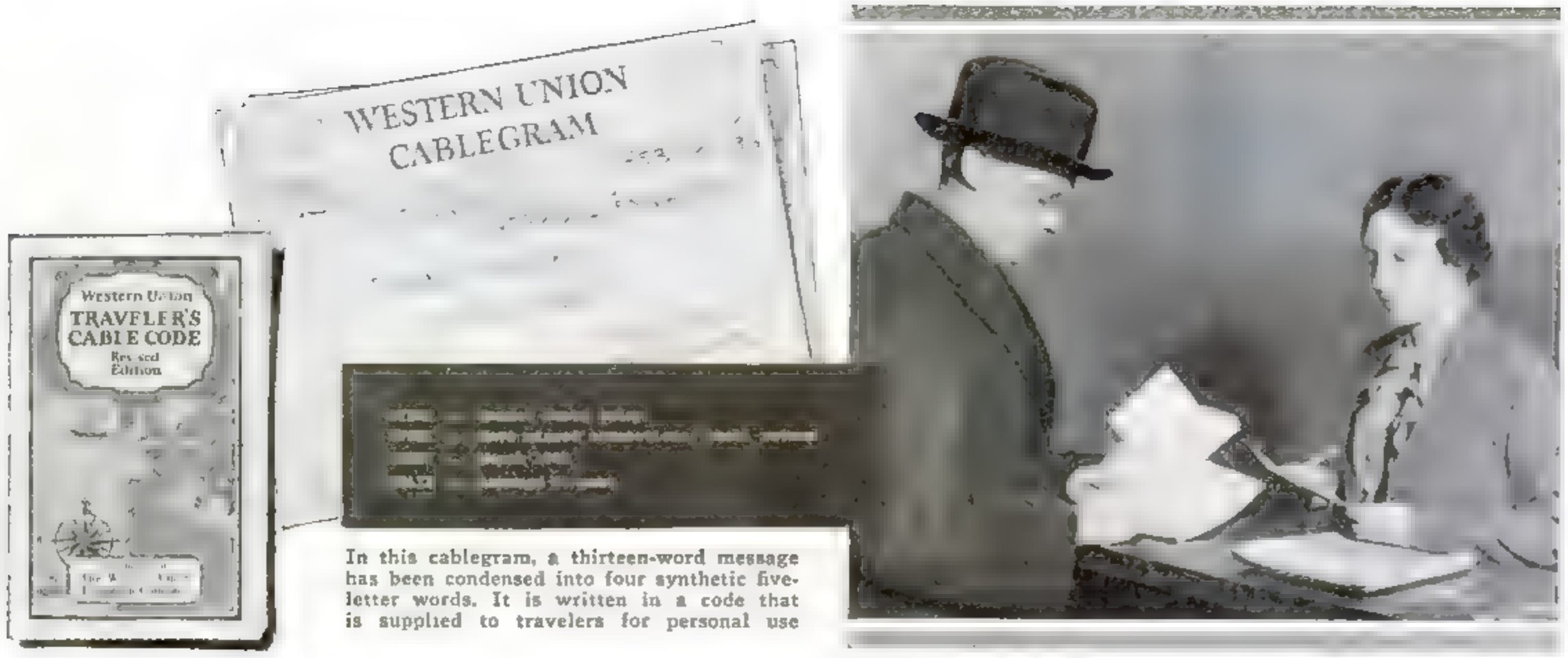
HAIR-CLOTH SPRINGS CUSHION CAR SEATS

DOUBLE doughnuts, composed of rubber and hair cloth, form the latest innovation in automobile upholstery. Looking in cross section like rows of tiny figure eights standing on end, these cloth-and-rubber springs form two honeycomb layers between the regular steel springs and the top fabric of the seat. Besides adding to the smoothness of the ride, the cellular layers are said to give improved ventilation.

CHEMICAL TO COUNTERACT WAR GAS

WAR GASES may lose some of their terror if the claims of a French chemist, who announces the discovery of a chemical preparation that has the property of neutralizing their toxic effect, prove to be justified. An advantage of this anti-gas agent is the simplicity of its use. The chemical, a pulverized solid, is designed to be sprayed into a room from a hand pump, and is said to counteract noxious vapors present and to aid in reviving persons already affected. In tests, its use is declared to have resuscitated mice that had been poisoned by carbon monoxide, one of several toxic gases against which it is said to be effective.

Chemist testing anti-gas powder in experiment with mice



In this cablegram, a thirteen-word message has been condensed into four synthetic five-letter words. It is written in a code that is supplied to travelers for personal use

WORDS MADE TO ORDER FOR The Strange

JUSTIFY mountain terrible unseen. CPRXD VLMTP.

These are not delirious ravings, followed by a jumble of spilled type. The first four words, in an old-style cable code, mean: "Motor breakdown. Send your nearest technician at once." And "CPRXD VLMTP" is a shorter, up-to-the-minute way of saying the same thing! It is from one of the newest codes, of artificial five-letter "words," built according to the very latest international rules which in the last two years have been changing the cable language of the world.

Though the general public encounters codes most often in detective stories or puzzles, they have an everyday use which is even more spectacular because of its tremendous scope. In hundreds of variations, this mysterious, compact language flows continually through undersea cables and inland wires all over the globe. Code messages handled by telegraph companies within the United States run into millions every year. More than three fourths of all ordinary fast cable communications with foreign countries are in code. In a single day, about a year ago, European cable offices counted nearly 38,000 code messages for North and South America. That was about nine times the number of ordinary fast messages, and more than half of all cable communications.

The vast majority of code messages are sent by commercial users. Unlike military and diplomatic codes and ciphers, in which the chief aim is secrecy, commercial codes are intended primarily for economy. By condensing messages, and thus reducing telegraph tolls, they make it practical for thousands of business firms and individuals to keep in touch with the swiftly moving world of commerce and industry.

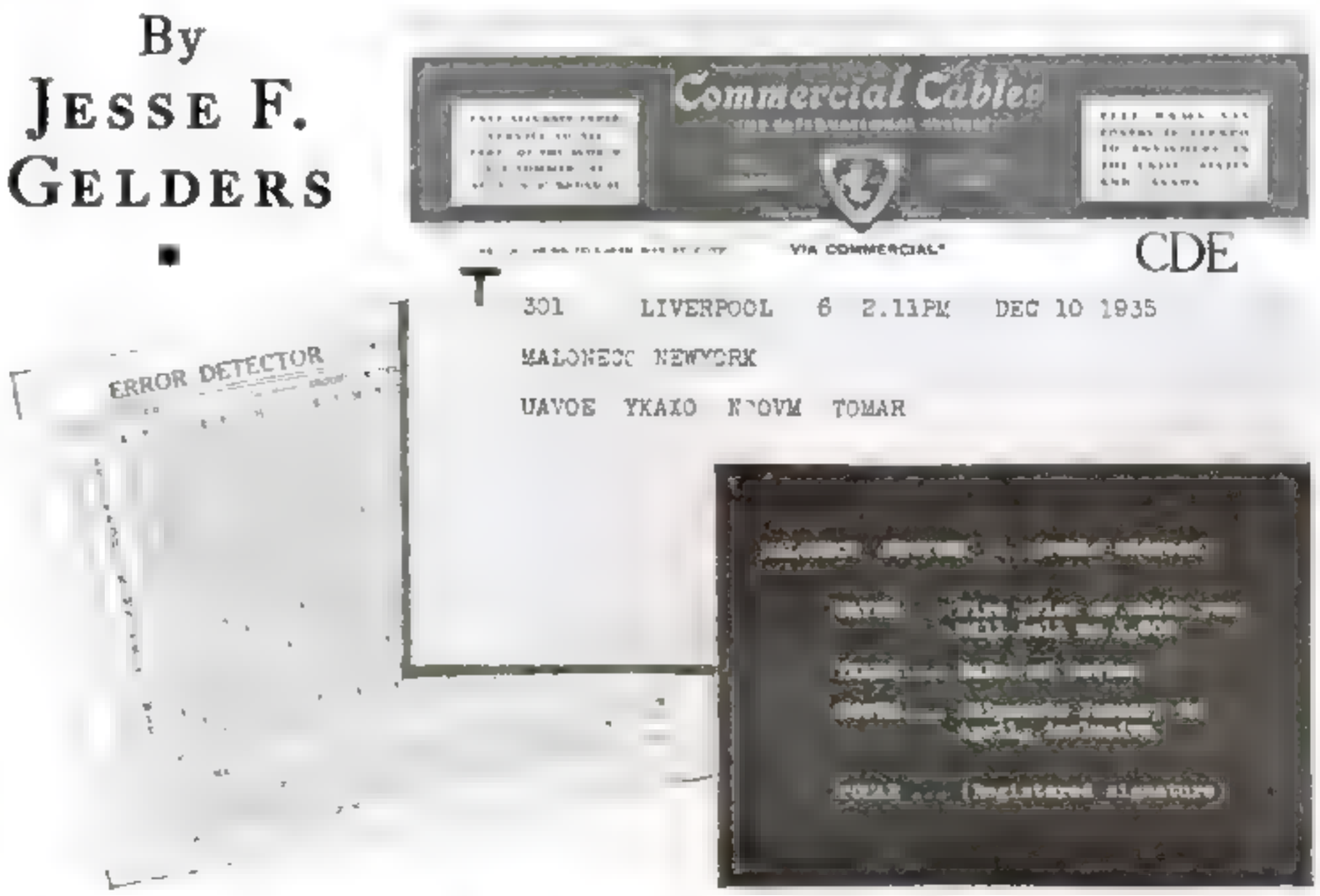
At the same time, they are indispensable for another, amazing reason. If all messages were sent in plain language, they would be swollen into a vast mass of words, five to ten times what they are in code. During heavy business periods, many communication lines would be clogged to the point of serious delay. By "stepping up" long, detailed messages into short, high-voltage words, codes serve communication in the same way that transformers aid in the long-distance transmission of electricity.

Varying needs bring hundreds of codes into active daily use. They range from pamphlets of a few pages, for travelers' personal messages, to massive volumes for highly technical industries. Many "public" codes, for general business, have achieved the circulation of popular novels. One, containing 100,000 phrases, had a sale of more than 50,000 copies. Differing in other respects, virtually all employ the same principle to conserve their users' time. Alphabetical arrangements and indexes of subjects guide the sender to the wanted phrase or sentence.

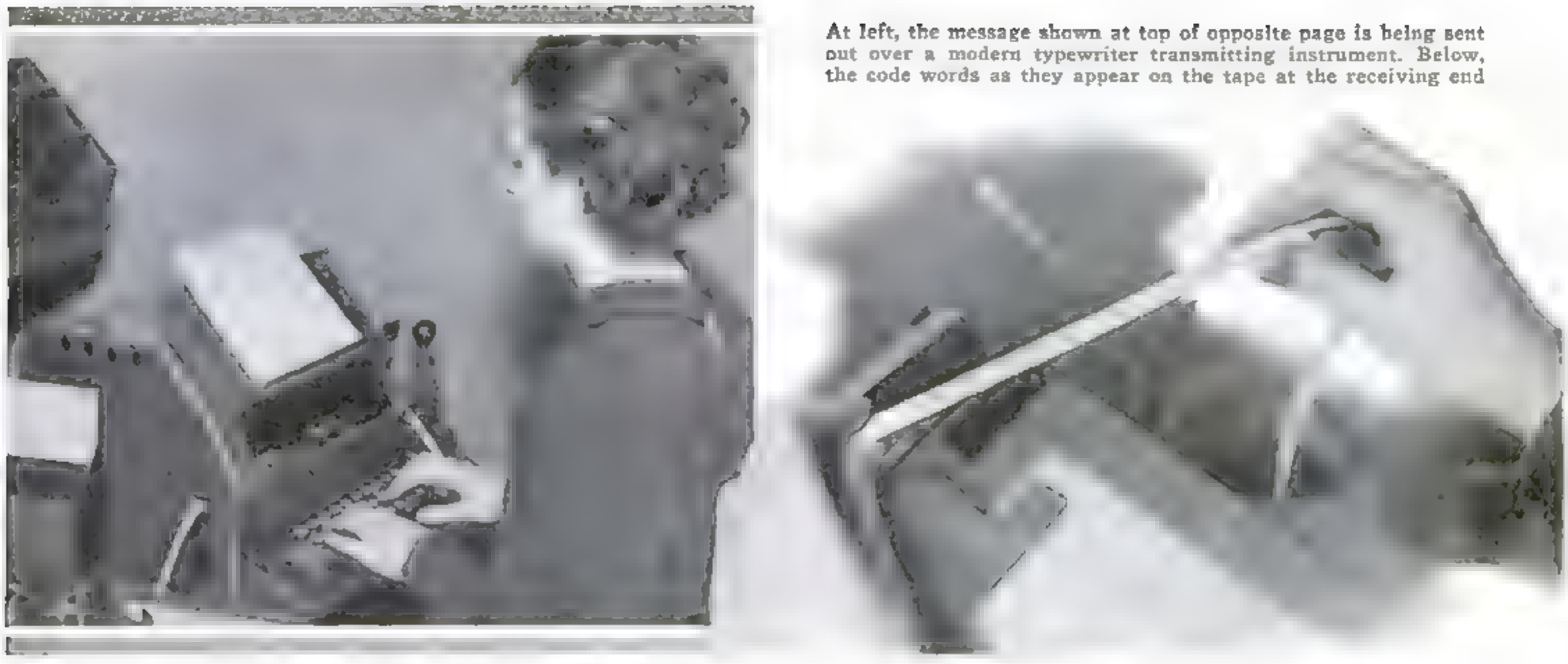
Building codes is an industry in itself. In America, there are about a dozen large professional code-making companies. Besides these, a number of large corporations employ their own experts to make private codes, or adapt the professional code companies' works to their special needs. Frequent changes in vocabularies are made necessary by new sales plans, new products, styles and colors. But the greatest recent change was linked with progress in the telegraph industry.

At one time, when messages were sent by the old dot-and-dash system, codes had to consist of "real" words, so that operators could carry them in mind while sending and receiving. Later, when "artificial" words were allowed, they had to be "pro-

By JESSE F. GELDERS



A business message in a commercial code, and a translation. The "error detector" at the left enables the person receiving the cable to correct any word that might be garbled in transmission



At left, the message shown at top of opposite page is being sent out over a modern typewriter transmitting instrument. Below, the code words as they appear on the tape at the receiving end

Language of the Cables

How Professional Code Builders Create a Fantastic Vocabulary To Carry Business and Personal Messages Over Telegraph Lines Laid Across the Ocean Depths

nounceable." Such restrictions have been made unnecessary by modern instruments that are operated as typewriters to send and record messages automatically.

Delegates from seventy-five countries finally decided to let down the bars, after international telegraph conferences had studied and debated the long series of changes for some fifty years. The United States Government, and American companies, while not conference members, were represented by "observers," and American companies led the way to the new system by adopting much of it inside our borders several years before it was accepted internationally.

Permission to form artificial five-letter "words" either with or without vowels was a momentous concession to code builders. It gave them over four times as many code words to work with.

They can combine the twenty-six letters of the alphabet in exactly 11,881,376 five-letter groups. In order to reduce chances of error in transmission, they usually make every word different from every other by at least two letters. This cuts the possible combinations to about 450,000. But when two letters of every five had to be vowels, there were only about 105.000 usable combinations.

Now, 100,000 variations always had been considered enough for any code. But code makers quickly discovered ways to profit by their expanded vocabularies. By having more code words to choose from, they could pack more meaning into each one, and shorten every message.

Fantastic as it sounds, it was simple. The principle was strikingly illustrated when Ernest Peterson, professional code builder, revised a cash-register company's code.

The vocabulary contained 100,000 words, almost the limit under the old system. There were some 1,000 words, from "KAJAN" to "KUTAZ," each of which would convey detailed information about orders and shipments. "KUBOR," for instance, meant "We are shipping to you, in care of your agent at Shanghai—"

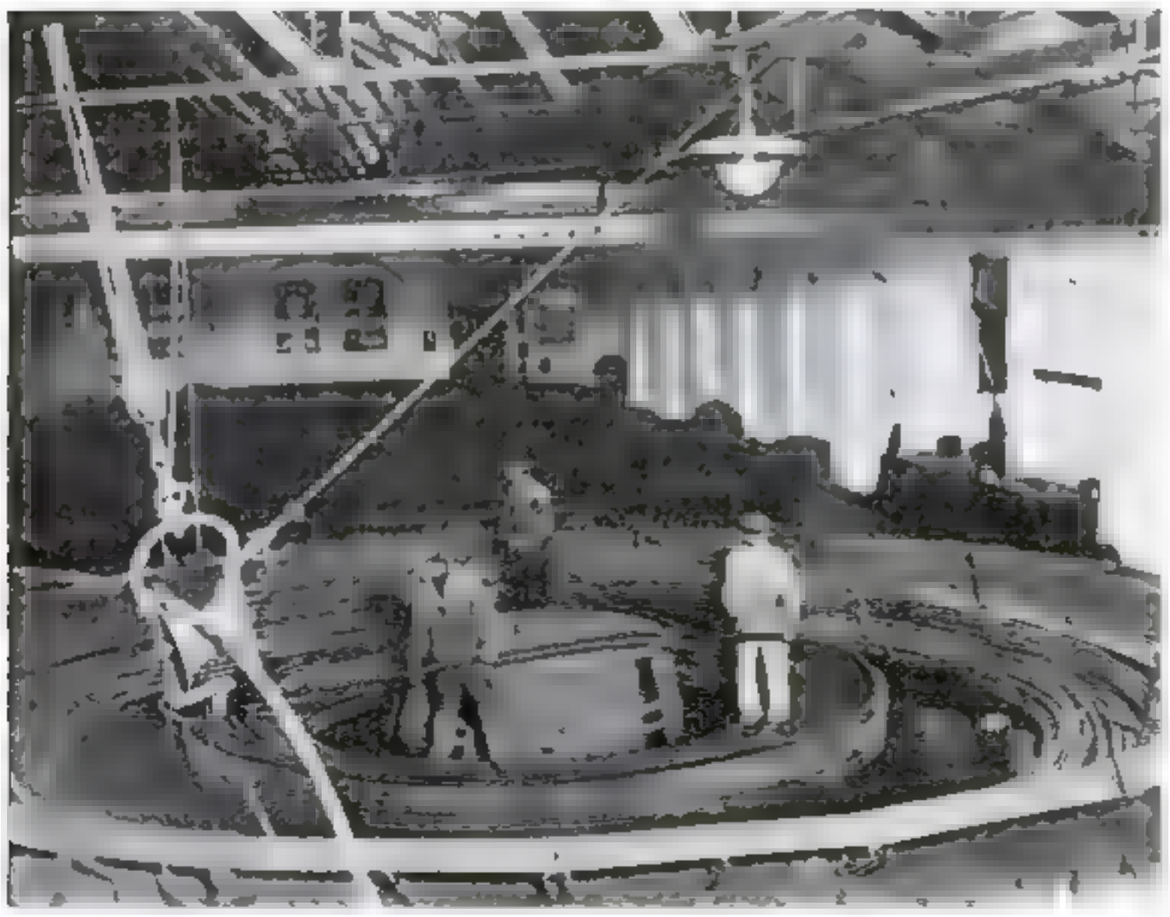
But the description of the machines being shipped, had to go into the next word of the message. Obviously, there would be a saving if the first word included the description, along with the shipping details.

Considering different combinations of colors, sizes, keyboards, and drawer arrangements, the company was producing about 200 styles of registers. The code maker combined each of the 200 styles with each of the 1,000 sets of shipping data—and chose a single code word for each combination. Altogether, that took 200,000 code words, twice as many as there were originally in the whole code.

He made similar changes elsewhere. When he had finished, the code could express the details of an ordinary transaction in two five-letters words, where formerly it required four.

Rebuilding a bank's code, he found the same opportunities. In certain messages, one five-letter word was conveying three kinds of information. It named a sum of money, which was to be paid. It contained a confidential symbol to verify the name of the person to whom payment was to be made. And it verified the amount to be paid.

The bank had to state, elsewhere in the message, whether the currency to be used was American, English, or French, or of the country *(Continued on page 86)*



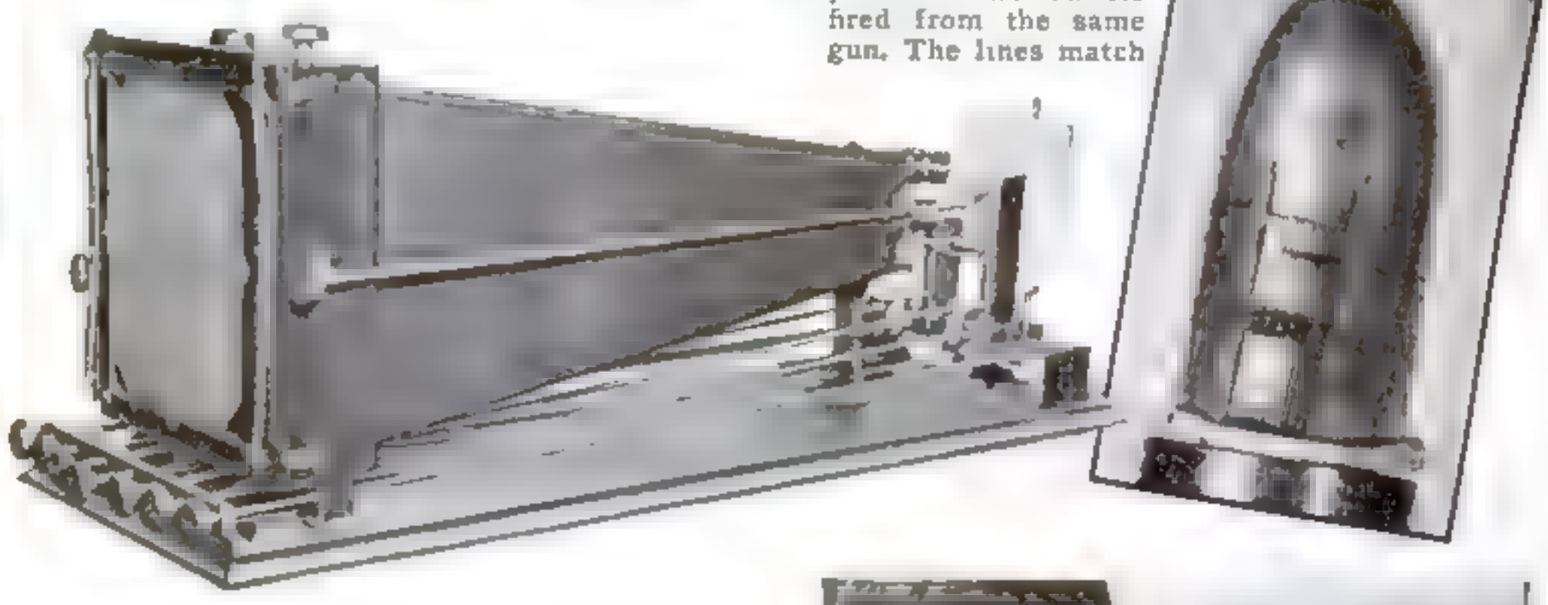
SPARE SUBMARINE CABLES

A submarine-cable depot in London, England, where undersea telegraph lines are stored to supply cable ships. The cables are stowed under water in tanks thirty-five feet in diameter. Each tank holds fifty miles of cable. Water keeps it in condition

COMPARISON CAMERA MATCHES MURDER-MYSTERY BULLETS

Prof. J. H. Mathews using the comparison camera he devised for matching marks on bullets. The apparatus is pictured at the right

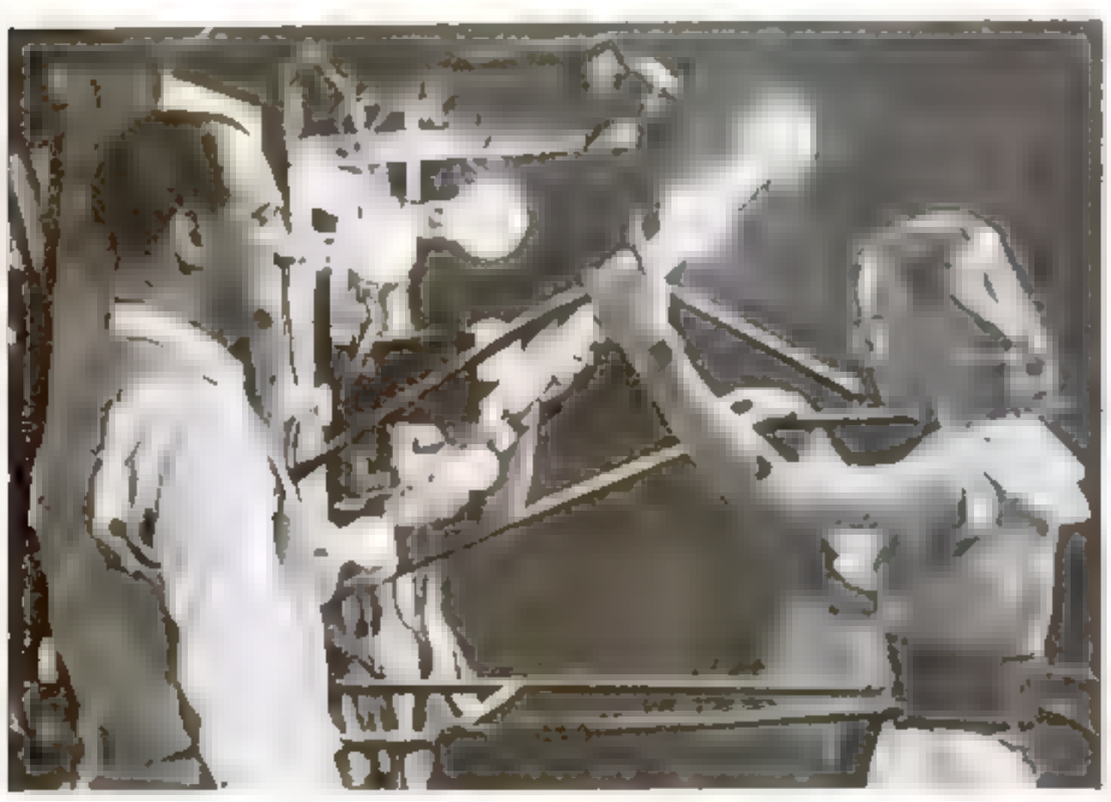
WHETHER or not the same gun fired two bullets is shown by a "comparison camera" developed by a University of Wisconsin scientist. When its two lenses are focused simultaneously upon a bullet picked up at the scene of a crime, and a test bullet fired from a suspect's gun, a composite photograph is obtained, consisting, for example, of the top half of one bullet and the bottom half of the other. If scratches on the two halves match, the two bullets came from the same weapon, since a gun leaves the same pattern of marks on every bullet that it fires. By manipulating levers that adjust twin platforms on which the bullets are mounted for photographing, any desired sections may be brought into juxtaposition and photographed for evidence.



The composite photograph at right shows parts of two bullets fired from the same gun. The lines match

NEW MOVIE DEVICE FILMS DANCERS

WHEN a movie actress appears to be gazing soulfully into the eyes of a dancing partner while gliding around the floor of a ballroom, she may actually be going through the motions of a fox-trot or waltz with a camera on wheels. A "dancing camera," devised in Germany for obtaining such close-up shots, is attached to the performer by a leather belt strapped about her waist, while her arms rest on supports and maintain a realistic pose. As the actress goes through dance movements, the camera follows, always in focus.



An actress strapped to the dancing camera which is mounted on wheels to roll around the ballroom floor

FOOT PEDAL SETS CARRIAGE OF TYPEWRITER BACK

A NEW attachment operated by a foot pedal sets a typewriter carriage back for another line without the hands being lifted from the keyboard. When a typist comes to the end of a line, she presses her foot on the floor pedal; this is connected to an automatic spring mechanism on the rear, righthand side of the machine which pulls the carriage back to starting position and spaces the paper for the next line. The device is adjustable for varying speeds and spacing. It is said to increase both speed and accuracy in typing and to require no special tools for attaching it to any typewriter. The photograph, at right, shows the mechanism in use.

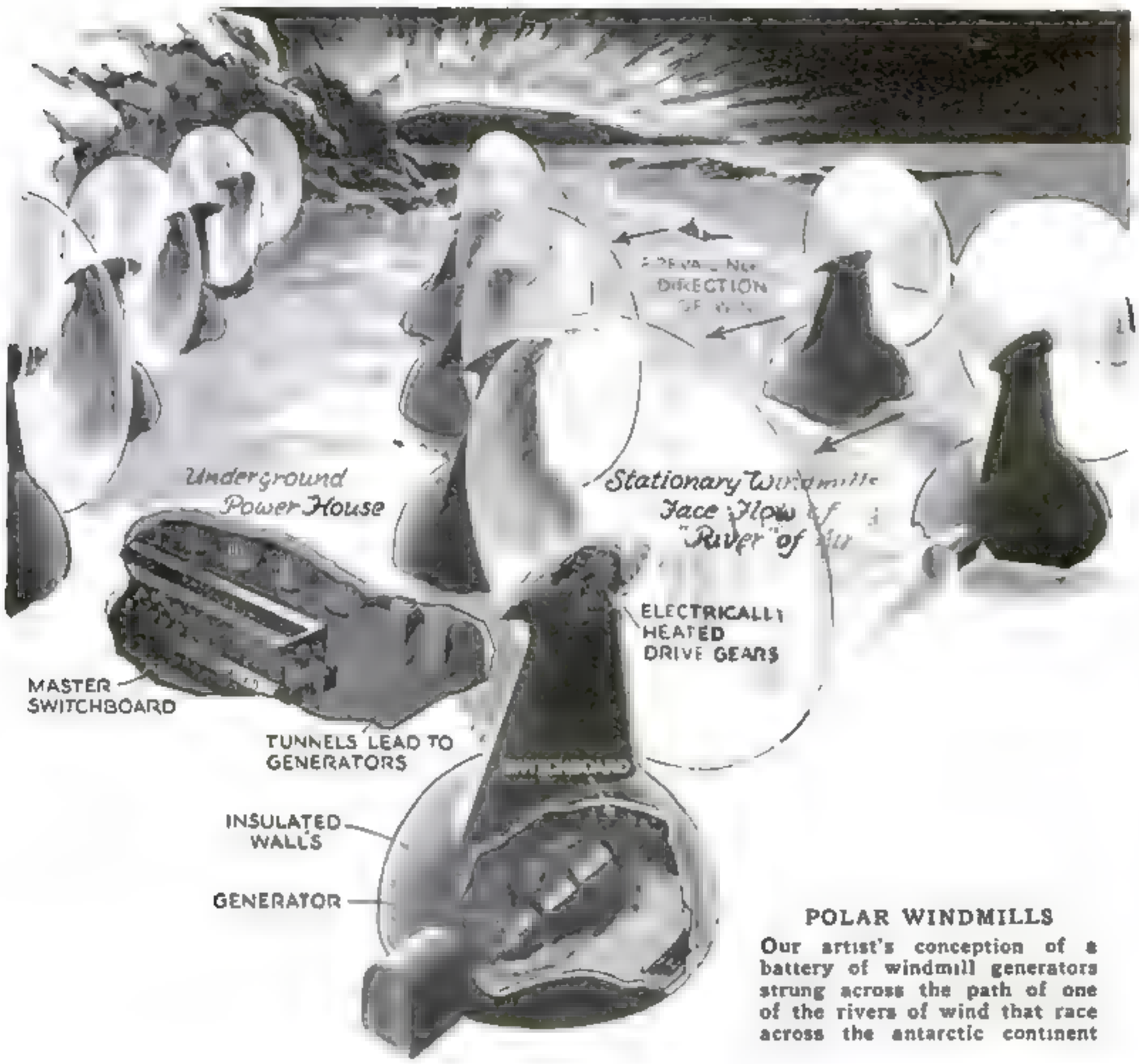
COMPASS IN BINOCULAR SHOWS DIRECTION

BINOCULAR and compass are combined in a single instrument developed in England. When the user sights through the field glasses, he sees the image of a built-in compass dial, projected into the field of view as shown in the drawing above. Thus he can readily view objects whose bearings he has ascertained from a chart, or obtain the bearings of a distant target to identify it on the map.

FINDS BIGGEST INSECT

FROM part of the wing of a prehistoric dragon fly recently found in a Kansas limestone bed, Dr. Frank M. Carpenter of Harvard University has estimated that the insect was two and a half feet long.

Harnessing Icy Polar Gales for Power



POLAR WINDMILLS

Our artist's conception of a battery of windmill generators strung across the path of one of the rivers of wind that race across the antarctic continent

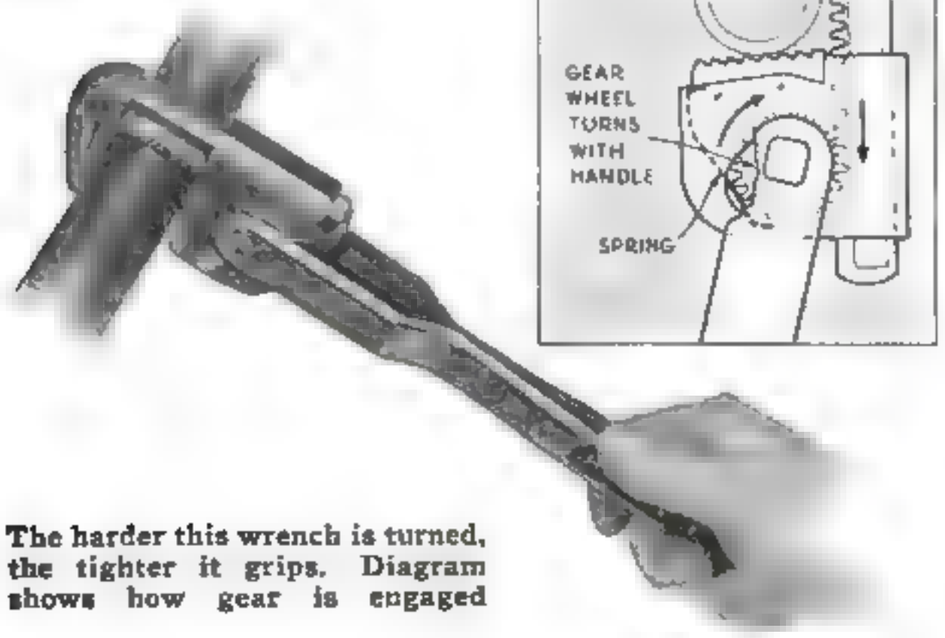
RIVERS of icy wind fifty miles wide and hundreds of feet deep, howling across the frozen wastes of the antarctic at seventy feet a second, will be harnessed by future generations to provide light and power, according to a forecast made by Prof. Frank Debenham, British scientist. Giant windmill generators may be strung across the path of such frigid air streams as the one known to blow outward from the barren plateaus of Adelie Land at a constant and almost incredible speed. Mounted on streamline steel towers, mammoth metal vanes whirling at high speed in the torrents of polar wind would tap an energy supply far greater than that created by the 6,000 tons of water which rush over the brink of Niagara Falls every second. With this tremendous supply of electric power available, it may be possible to push the frontier of civilization far down into the antarctic area to recover the vast mineral wealth believed to exist in the mountains of the south polar region, much as the large mineral resources of arctic Lapland, which had been untouched by man for ages, are today being tapped for their wealth by the abundant electric power produced by her icy rivers (P.S.M., Sept. '35, P. 34).

POISONS NEUTRALIZE EACH OTHER

POISONOUS wastes from factories along the River Tees in England are mixed to neutralize each other before they are dumped into the stream. When intermixed, British engineers discovered that two poisonous wastes, each from a selected factory, would combine chemically to form a harmless compound.

NOVEL PIPE WRENCH CAN'T SLIP

A PIPE wrench recently introduced cannot slip its hold; the harder the user pushes the handle to twist a section of pipe, the tighter the jaws of the tool grip the metal. Inclosed in the body of the wrench and attached to the upper end of the handle is a gear wheel engaging a rack in such a way that a turn of the handle opens or closes the jaws. The user can depress a spring mechanism to disengage the gear connection and to adjust the opening of the wrench to the required size.



The harder this wrench is turned, the tighter it grips. Diagram shows how gear is engaged

ALUMINUM TESTED AS MATERIAL FOR SHIPS

IN THE future, ships may have hulls made of aluminum instead of steel or wood. A six-ton, aluminum-alloy hull "fragment," representing a ten-foot cross section of a 100-foot boat, was launched recently at Bath, Me. It will undergo extensive tests at Newport News, Va. to which point it was transported by rail. The alloy is much lighter than standard hull materials. If experiments prove it to be the equal of steel or wood in strength and resistance to corrosion, the designer predicts a new era of speed for marine craft, since the saving in weight for the hull will permit a greater allowance for the installation of the power plant. The novel ship section, christened *Alumette*, is pictured above.

TINY PLANE COSTS ONLY $100, EXCLUSIVE OF ENGINE

Edwin Nirmaier, Cincinnati, Ohio, pilot, and the 316-pound midget plane he designed

PATTERNED after a diminutive type of airplane that has attained wide popularity in Europe, a novel single-seater biplane constructed by a Cincinnati, Ohio, pilot is under six feet high, has a wing spread of less than twenty feet, and weighs but 316 pounds. Built in four weeks, the "Sky Flea" cost only $100, exclusive of the two-cylinder motor-cycle engine. The plane's rudder shaft ends in two small rear wheels, and wires operated from the open cockpit turn the wheels to steer the plane on the ground, or adjust the rudder in flight. The exhaust pipe extends back over the top wing to keep exhaust fumes away from the pilot. Despite its low cost, it has operated efficiently.

NOVEL CARDBOARD SIGNS SHINE IN THE DARK

CARDBOARD signs of a new type glow in the dark by reflected light. Small holes punched in the letters of the sign let light through to a thin sheet of metal foil which has been stamped and indented to provide a number of reflecting surfaces.

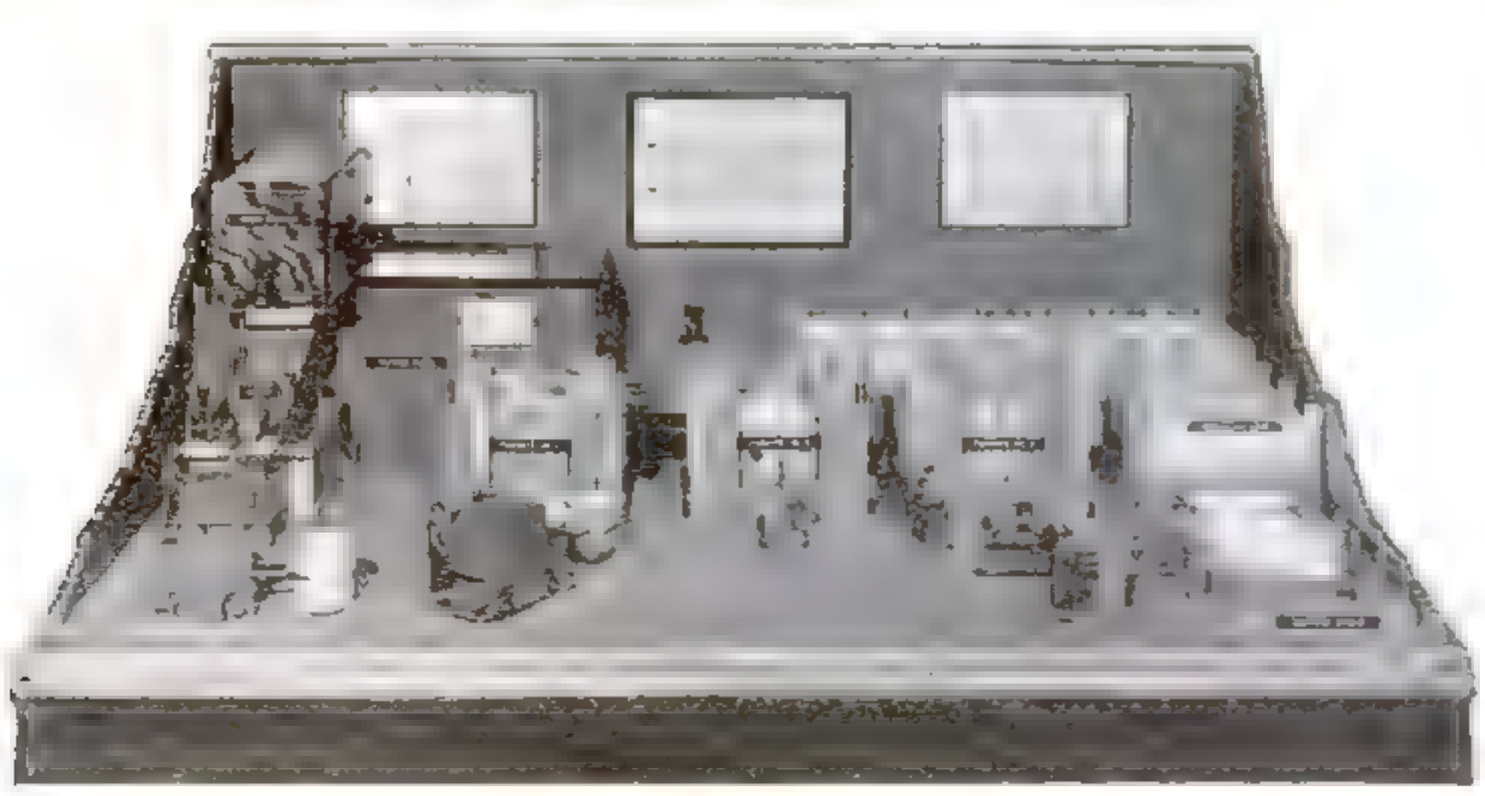
NEON TUBE IS "MAGIC" DRINK STIRRER

GLASS ornaments and drink stirrers light up mysteriously when brought near a table recently marketed for use in bars, cafes, and restaurants. Electric current operates a radio tube and transformer in the pedestal of the table. A high-voltage, low-amperage charge is transferred to a tinfoil filament under the composition table top, setting up a high-frequency field. When tubes filled with neon and other gases come within four inches of the table, they glow with a weird effect.

Electric field on table causes these neon-tube ornaments to glow

MODEL FOUNDRY SHOWS GLASS MAKING

FURNACES glow, fire-box doors swing open, a mixer grinds, glass stirrers whirl, and tiny electric trucks trundle pots of "molten glass" to a casting table in an ingeniously constructed miniature glass factory recently completed by the Bausch & Lomb Optical Company at a cost of $8,000. Five motors, fourteen electric circuits, fifteen automatic switches, and six relays are required to drive the levers, gears, rollers, and chains that operate the realistic model. Each step in the glass-making process is explained by legends automatically flashed on a screen. The diminutive glass plant took a year and a half to construct. It will be shown at scientific meetings, industrial conventions, and museums throughout the country.



As "glass" is manufactured in this working model of a foundry, legends flash on screen at center

PIPE BOWL IS SPLIT FOR DUMPING ASHES

TO REMOVE ashes from a pipe recently invented, the smoker merely pulls apart the cherry-wood bowl, which is constructed in two sections hinged at the bottom. When the hinged halves are closed, two flanges of heat-resisting metal set into the wood overlap to form an air-tight joint.

DRUG CURES "SLEEPERS"

PERSONS afflicted with narcolepsy, or constant sleepiness, are being treated with benzedrine, a new drug which keeps people awake. In a recent test, nine chronic "sleepers" who received the drug obtained complete relief. Benzedrine is also useful in treating muscular disorders.

NEW PORTABLE STROBOSCOPE USES FLASHING NEON LAMP

New portable stroboscope in use in an engine-testing laboratory

A vibrating spring in ordinary light

Vibration "stopped" by stroboscope

READILY portable and operated from any electric outlet, a new compact stroboscope may replace bulkier and costlier models heretofore employed in industry to make moving machinery appear to stand still in order to check the behavior of rotating and vibrating parts. All such devices "stop" motion by illuminating a machine intermittently, the flashes of light being timed to coincide with a recurring point in the machine's cycle of operation, and the new instrument employs a powerful neon lamp of improved design for this purpose. The instrument, according to the inventor, is also highly efficient when used as a tachometer.

SPIRAL TOOL TRUES ABRASIVE WHEELS

ABRASIVE wheels are easily leveled and made true with a spiral cutter recently marketed. The device is held against the wheel as it revolves; it is not necessary to move it back and forth across the wheel surface, since the spiral arrangement automatically trues the wheel. Cutters are manufactured in three interchangeable styles for fine, medium, and coarse work.

WAR PLANE SHOUTS WARNINGS TO REBEL TRIBESMEN

GIANT loudspeakers take the place of bomb racks under the fuselage of a huge war plane used by the British Royal Air Force to subdue rebellious native tribes in Irak, a British mandate in Mesopotamia. Officers report that words of warning spoken into cabin microphones and thrown down from the sky by means of powerful amplifiers prove more effective than bombs in quelling tribal revolts. Native interpreters, or officers familiar with the local vernacular, serve as "announcers" in this novel form of control. In addition to its use against actual rebels, the method is expected to be of value in ordinary police work in sparsely settled regions, or for directing large masses of people. Officials plan to try the same system in Somaliland, Northwest India, and other countries under the control of the empire which have large tribal populations.

British bombing plane with loudspeakers mounted under its fuselage for shouting words of admonition to rebellious tribesmen on the ground

THREE-WHEELED CARS CARRY AID TO AUTOISTS

Highway patrolmen of the Automobile Club of Southern California, demonstrating the various services they perform for motorists. Complete equipment for medical and mechanical first aid is carried in the three-wheeled motor-cycle trucks

HIGHWAY patrolmen employed by the Automobile Club of Southern California (P.S.M., June '35, p. 20) now tour the roads in new three-wheeled motorcycle trucks fully stocked and equipped to render mechanical and medical first aid to motorists in distress. In the photograph at the left, eight of these "Good Samaritans of the Highway" demonstrate simultaneously the important types of service they perform.

Uncle Sam's Money Magicians

RESTORE MUTILATED CURRENCY

One of the six Government specialists in identifying mutilated money, examining a charred bill under a magnifying lens. At left, a safe-deposit box salvaged from the S S *Morro Castle*. The fragments of currency in the drawer were identified to the extent of $4,700

WOOD CHOPPERS in Alabama, not long ago, stumbled upon six mysterious tree stumps. In the hollow of one, they noticed a wad of sodden paper. It proved to be $300 in rotting bills. A quarter of a mile away, another stump held $200. Axes were thrown aside and a treasure hunt ensued. Running from stump to stump, the men found that half a dozen contained hidden money. The total was more than $1,000.

Where the bills came from is still a mystery. Police believed they were cached by robbers who were caught before they could return for their loot. All the bills were weathered almost white, and most were so rotted they fell into fragments. But experts of the Damaged Money Division of the U. S. Treasury in Washington made out the serial number on every bill and replaced the money with new currency.

Under the direction of Miss Bertha O. Sherfy, the six women experts of this unique laboratory handle millions of dollars in mutilated money. Bills that have been burned, buried, eaten by acids, mangled by lawn mowers, chewed up by termites, swallowed by goats—all are familiar to these fortune restorers.

Wearing aprons and using laboratory apparatus, the women put each mutilated bill through a scientific "third degree" to determine its identity. According to Government rules, three fifths of a bill must be present to be redeemed at full value and two fifths to be redeemed at half value. When less than two fifths of a bill is recovered, the claimant must present evidence of good character and must sign an affidavit that the rest of the money was completely destroyed.

Not long ago, in the South, a workman in a cigarette factory dropped his pocketbook containing all the money he had in the world. Before he could recover it, it slid into the hopper of a huge shredding machine, and when the bills appeared they had been chopped into fragments. In spite of this, the tiny shreds were pieced together in the Washington laboratory and new money was issued.

Buried money is often hardest of all to identify. Dampness and decay destroy the engraving marks on the bill which are vital to determining its identity and value. There have been more than 130 issues of currency, and the denominations run from one dollar to $10,000. Yet, the experts in Washington can tell from a clear fragment, almost at once, both the denomination and issue of a given bill.

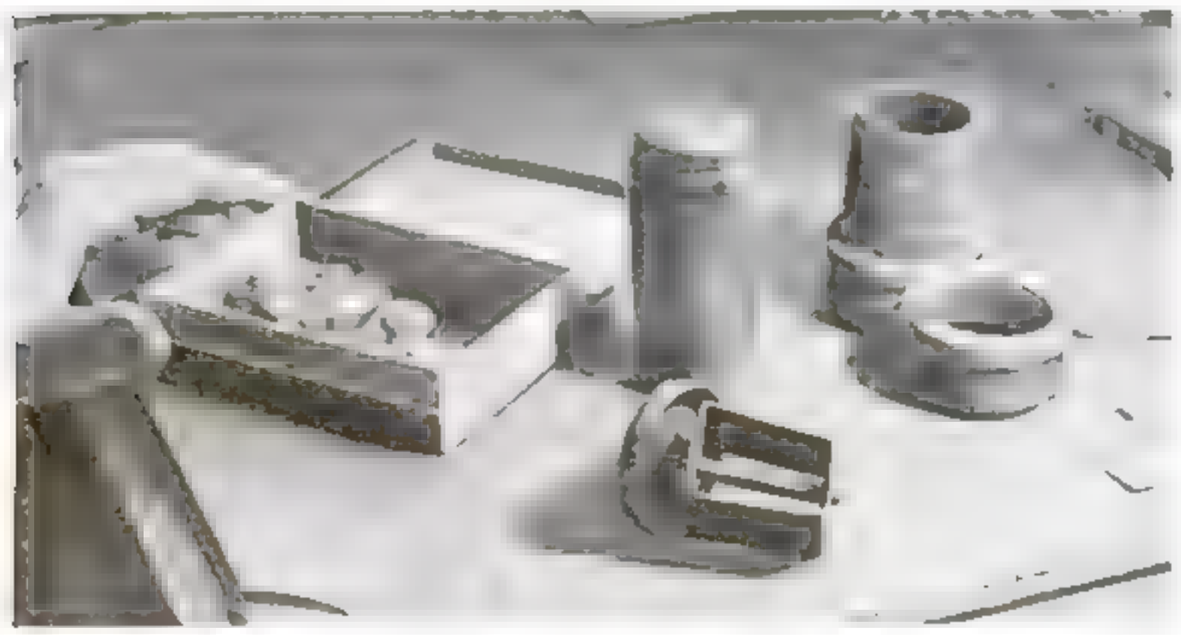
In South Dakota, not long ago, a farmer began tearing down the foundation of a chicken coop on a farm he had just purchased. Rotting in the wet ground under one of the planks, he discovered a roll of hidden money. It had lain there for decades, evidently left by some previous owner of the land. The finder forwarded it to Washington. Here the faint engraving marks were brought out and the currency was identified and replaced with new bills.

When newspaper headlines tell of a hurricane, a flood, a tornado, or a fire at sea, Miss Sherfy and her associates know that additional work is heading their way. Each disaster produces its crop of burned or mutilated money. For weeks after the recent Florida hurricane, torn and rain-soaked bills came to Washington from victims of the catastrophe.

Two metal boxes, blackened and bent by the terrific heat on the *Morro Castle*, the liner which burned off the New Jersey coast in the fall of 1934, are among Miss Sherfy's prized possessions. They were the purser's money boxes, snatched from the smoldering ruins of the ship. Of the $5,400 held by the boxes, $4,700 was identified by the Treasury laboratory, even though many of the bills were seemingly charred beyond recognition.

In examining burned money, the first step is to get rid of the foreign matter and sort the remains of the bills into the separate denominations. With mucilage, the bits of charred material are stuck in place upon paper approximately the size of the original bill. The "recovered notes" are then placed between blotters under heavy weights until they are thoroughly dry. Later, each note is measured carefully to determine how much of the original remains.

Where do people hide their money? Her seventeen years' experience as head of the Damaged Money Division has given Miss Sherfy a pretty good idea. Favorite spots are pepper boxes, *(Continued on page 121)*



METAL KEEPS MONEY BEST

The metal pipe fitting, pepper shaker, and bed caster at the left protected hidden money from fire. The cigar box contains the remains of a drinking glass that melted and mixed with the currency

A student pilot "going under the hood" before starting a training flight. Each tyro receives twenty hours of blind-flying instruction before he is permitted to see what the ground looks like from a flying plane

Superpilots of Tomorrow

LEARN TO FLY BY INSTRUMENT and RADIO

Holding his hands above the cockpit, the instructor shows that this ship is under the control of a beginner, flying blind

Rigorous training course in blind flying prepares daring students to serve as skippers of the giant airliners of the future

By
ANDREW R. BOONE

ACROSS the continent roars a trimotored airliner, recently retired from commercial service. In her large cabin, a dozen young men are busy mapping her course, taking shots at the sun with an octant, figuring drift, correcting air speed for altitude and temperature. At the controls, "blind" except for a view of the instrument panel, sits a student pilot following the on-course drone of a radio-beam signal.

Spiraling upward, again blind under the hood, another youngster takes his training plane to 3,000 feet, levels off, and speeds through the California sky for a timed flight.

Carefully observing his clock, turn-and-bank indicator, and finally his radio-beam centering device, yet another glides in on two invisible landing beams until his wheels touch earth and he rolls to a stop.

For the first time in the history of aviation, embryo flyers are jumping off blind to start their training as transport pilots. When I visited the Boeing School of Aeronautics recently to find out how inexperienced boys who have never flown are learning in the course of a few weeks to pilot planes long distances from their home field at Oakland, Calif., and back again with the accuracy of homing pigeons, never viewing the earth, I got a preview of the superpilots who will fly tomorrow's superplanes with an accuracy unknown to old-time airmen.

I not only watched these boys from the ground as they put their training planes into tail spins and pulled them out again, "flew the beam" in large ships which once carried mail, and floated down in a seven-ton transport, following the landing beams to the ground. I went aloft, flying with a student who, during four

hours "under the hood," had never seen the earth from the air.

Each of these boys flies twenty hours before he is permitted to look over the side for a view of the ground. For them, flying "by the seat of the pants" is ancient history. They are learning from the start to rely on the gyroscopic turn indicator, artificial-horizon bank indicator, air-speed meter, magnetic compass, altimeter, rate-of-climb indicator, a watch—and radio.

Suppose we go up for a closer view of an instrument-and-radio flight. Our student pilot in the dark forward cockpit is Dale Scott, who went west from Great Neck, Long Island, to join the pioneer class of blind fliers. LeRoy Gregg, a diminutive instructor who, in coaching 335 students during his long aviation experience, has acquired considerable authority as to the right and wrong ways to handle airplanes, occupies the rear cockpit. I am sitting in the comfortable passenger's cabin of the former mail plane, a pair of 'phones clamped over my ears. Engine idling, the plane is standing at the edge of the Oakland airport, her nose pointed toward San Francisco Bay.

Members of a class in avigation taking observations of the sun and earth from cabin windows

Above the noise of the 475-horsepower engine, Gregg's voice rasps through the interphone:

"Is your hood down tight, Scotty? Are your shutters open, and is your stabilizer set?"

"Yes, sir."

"All right." Gregg continues. "We're going to try holding the beam today. I'll take her off and up to 200. You go straight ahead to 1,000, spiral left to 2,000, and then make a right-hand spiral to 3,000. And check your time closely."

Instructions ended, Gregg opens the throttle. The ship leaps forward, down comes the tail, and up we roar. At 200 feet, the left wing dips slightly, indicating that Scotty has taken over and we are starting a forty-minute flight of precision, climbing by watch and turn-and-bank indicator to 3,000 feet, soon to soar out over the hills guided by the narrow and invisible radio range beacon, to turn at last and follow the ever-narrowing beam back to the home port.

Straight ahead we fly, until the altimeter in the cabin registers 1,000 feet; then I feel the plane bank slightly. We are climbing 400 feet a minute, while the ship lies over on its left wing at a ten-degree angle. At intervals, Gregg breaks through with words of encouragement and warning.

"Remember, Scotty," the voice says, "I want a two-minute spiral. That will complete your circle. Hold your left rudder over and watch your turn hand. Check your air speed. Don't pull back on the stick coming out of the turn, or you may stall."

Scotty completes the circle after climbing 800 feet. Now the ship lies easily over on the right wing, and the student starts his timed spiral to the right. Again, for two minutes to the second, we climb. Precisely on the dot, Scotty levels off. We are on course, all right, but the altimeter registers, 2,200 feet.

"Fine going," the voice squeaks, "but short on altitude. I know you can't watch everything, Scotty, but keep your eye on your engine today. Rev her up to 1,750 and hold her there."

I feel the ship gather speed as Scotty eases the throttle forward. Again the circuit opens.

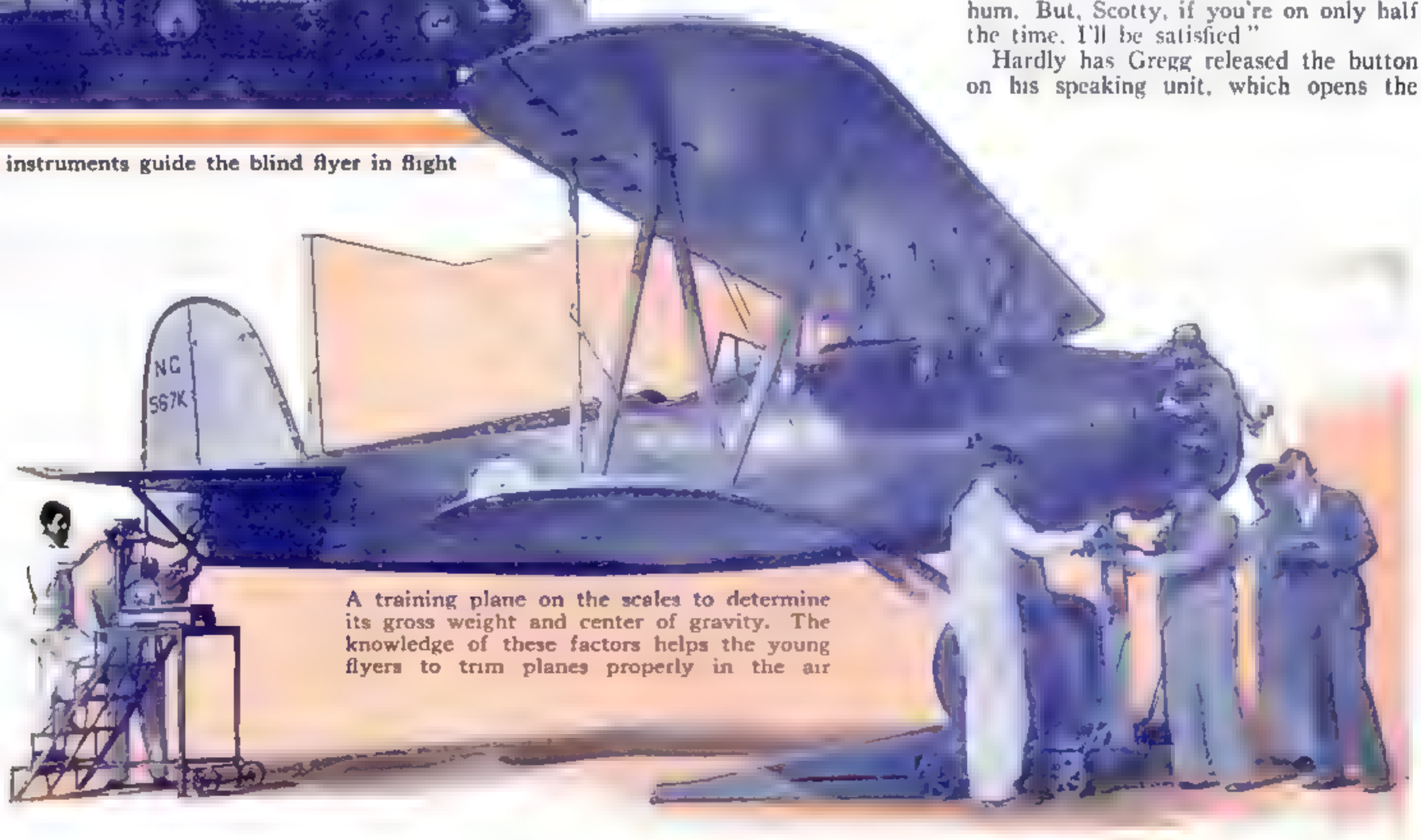
"We're going out the Livermore beam at 3,000. You'll have to climb a little going out. By the way, what should be your compass course?"

"Eighty degrees."

"That's right. Now remember, after we pass through the cone of silence the 'A' sector will be on the left, 'N' on the right. If you stay on course, you'll hear a steady hum. But, Scotty, if you're on only half the time, I'll be satisfied."

Hardly has Gregg released the button on his speaking unit, which opens the

These instruments guide the blind flyer in flight



A training plane on the scales to determine its gross weight and center of gravity. The knowledge of these factors helps the young flyers to trim planes properly in the air

A retired transport plane, now used as a flying class room, being tuned up for a trip. At right, students learn avigation, the aerial counterpart of navigation, in the cabin of this ship while soaring high above the earth

three-phone circuit for conversation, when the steady hum which has been flowing through my earphones ceases. We are now in the cone of silence, a "blank" radio space nearly a quarter-mile wide at 2,200 feet above the radio range station, whose shacks I see below. These are located near the edge of the airport. From them radiate four beams, down which radio-equipped planes may be guided to safety.

Seconds pass. We are now flying at 2,400 feet. As abruptly as it ceased, the ear-splitting hum commences again. We are fanning along toward Livermore, secure in the knowledge that this monotone of radio racing up from under our tail is guiding this student pilot as surely as any landmark. Now the hum breaks off, and the staccato dot-dash of the "A" comes through. As Scotty eases forward on the right rudder, holding the stick neutral trying for a flat, easy turn, Gregg corrects him:

"You kicked her over too hard, and you're in the 'N' sector now. Come back at ten degrees and turn to your compass course when you hear the hum."

Scotty swings back, climbing as he does so.

"You're bound to climb when you pull on your stick," the voice warns. "Let her go once. See, she's a little nose-heavy."

We hit the beam again, and once more the monotonous song pours into our ears.

"Atta boy, Scotty," says the interphone. "Now hold your rate of climb level. No. No. You are diving now."

Not what aviators call a nose dive, but a gentle glide. Yet, to a pilot flying a beam where altitude may be important, loss of a few hundred feet could spell the difference between a happy landing and death. Scotty brings the nose up, and soon we are flying at 3,000 feet. Back and forth we weave, now on course, again straying out into the "A" or "N" sector. The young pilot is taking his initiation on the beam like a veteran.

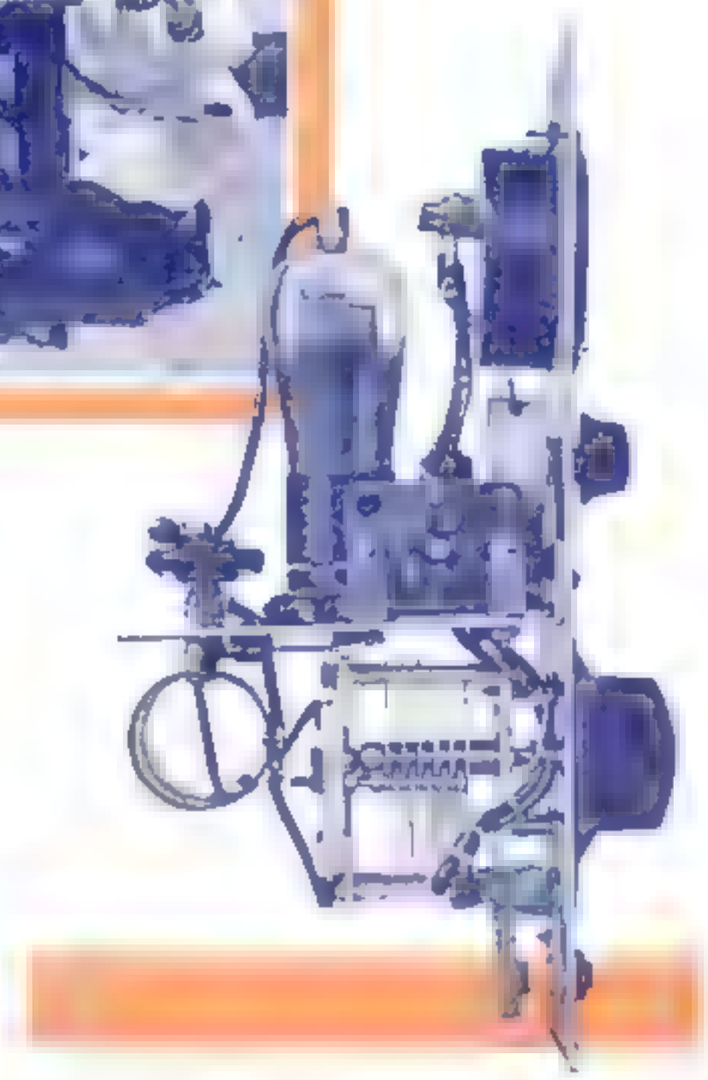
Through the rough air swirling up from the rolling hills beneath, Scotty plows along on course. The plane pitches and rolls fitfully as updrafts catch us under the wings. But the novice in the dark cockpit, guided by his ears and seven instruments on his panel, pilots the plane along the beam until Gregg again speaks.

"I'll give you a rest," he says, "and turn her around. We're about fifteen miles out now. Your course going

Airliner skippers of tomorrow assembling a motor which they will later install in a plane

George I. Myers, director of flying, explains the principle of the radio beam to a class. At left, embryo pilots testing an altimeter in a vacuum case to see how dependable it is

Instrument - flying pupils checking a radio landing-beam receiver for accuracy after a flight. Below, a high frequency oscillator used for testing receivers. Each pilot is required to qualify for a radio operator's license and understand the instruments he uses



home is 260 degrees. Keep her at 3,000. Remember, 'A's' are on the right, 'N's' on the left going in. And try to relax, Scotty. Everything's going fine."

Again the student takes over. He is tiring now from the strain, and in the rough air begins to overcontrol. In a short time, we climb to 3,600 as he weaves back and forth across the on-course signal. Gregg brings him back with a warning.

Only once more during the next five minutes does the instructor open the circuit, lending an encouraging voice to the weary student. "When you're in the beam, check with your compass," he says. "If you hold the needle at 260 degrees, you will not stray far off." Soon after Gregg signs off, the hum ceases. Once more we are in the cone of silence, thus concluding Scotty's first lesson on the beam.

Five minutes later, standing on the ramp alongside the one-man flying class room I saw a large trimotored plane gliding past the field, ready to follow a positively indicated radio path to earth. At her controls, too, sat a student under a darkened hood; beside him, a veteran instructor, ready to pull him out of trouble should he undershoot the field or threaten to make a pancake landing. On literally hundreds of occasions, student pilots of little experience have brought this large ship down safely on landing beams.

"Must be tough on a youngster to trust himself bringing a large plane down a radio beam," I commented to Gregg.

"Not so bad," he told me, "for those who have learned two things: to interpret their instruments properly, and to believe what their instruments tell them.

"This boy has just flown a definite compass course through the cone of silence. He knows where the field is located with reference to the cone. So, he glides into a turn and by timing himself and watching his altimeter, knows when he should enter the first marker beacon.

"You see, there are two landing beams sent out from the radio station at the far edge of the field. One is vertical, the other horizontal. As the student approaches the field two pointers on a combination dial, known as a radio-beam centering device, show him constantly whether he is straying to right or left, or above or below the proper gliding path.

"When he's 2,000 feet from the field, a vertical beam signals that distance, and another placed at the edge of the field tells him to drop her down to a landing. It's really quite simple—maintain the proper gliding angle, keep flying speed, watch the pointers, and fly her in until the wheels are rolling."

Although these youngsters fly daily under the hood, they're really well oriented at all times, for before their first flight they studied a map painted on the concrete apron near the flight house. Here they saw how the beams intersect at the cone of silence, and noted the position of the cone with relation to the landing field.

Six student pilots had amassed a total of 120 hours in the air when I visited the Boeing school—and not one of these knew what the earth looks like from an airplane. How do these embryo pilots feel as, in utter darkness, they zoom into the sky, spiral upward, spin, recover from stalls and slips, follow the beam, and finally bring their planes down to blind landings?

"Boring, utterly boring, as far as fun goes," one told me. "Can't see anything. The instructor tells you how the stick and pedals should maneuver the ship when you move them. Then you roar off the airport and try to remember what a half dozen instruments are trying to tell you. For a total of nearly two days you sit there, tense, trying to run the plane. I get along well enough for twenty-five minutes at a time, but the next ten are tough. Likely as not, I turn her on her back or unwittingly kick her into a spin. Of course, my altimeter tells me I am far enough from the ground and I know the instructor will keep me out of trouble. Oh, well, they say the first twenty hours are the hardest."

The secret of success—and safety—lies in proper timing. These boys fly by the watch. So many seconds for this, so many seconds or minutes for that.

"You always know where you ought to be," another student explained, "and if you've done everything right, that's just exactly where you are."

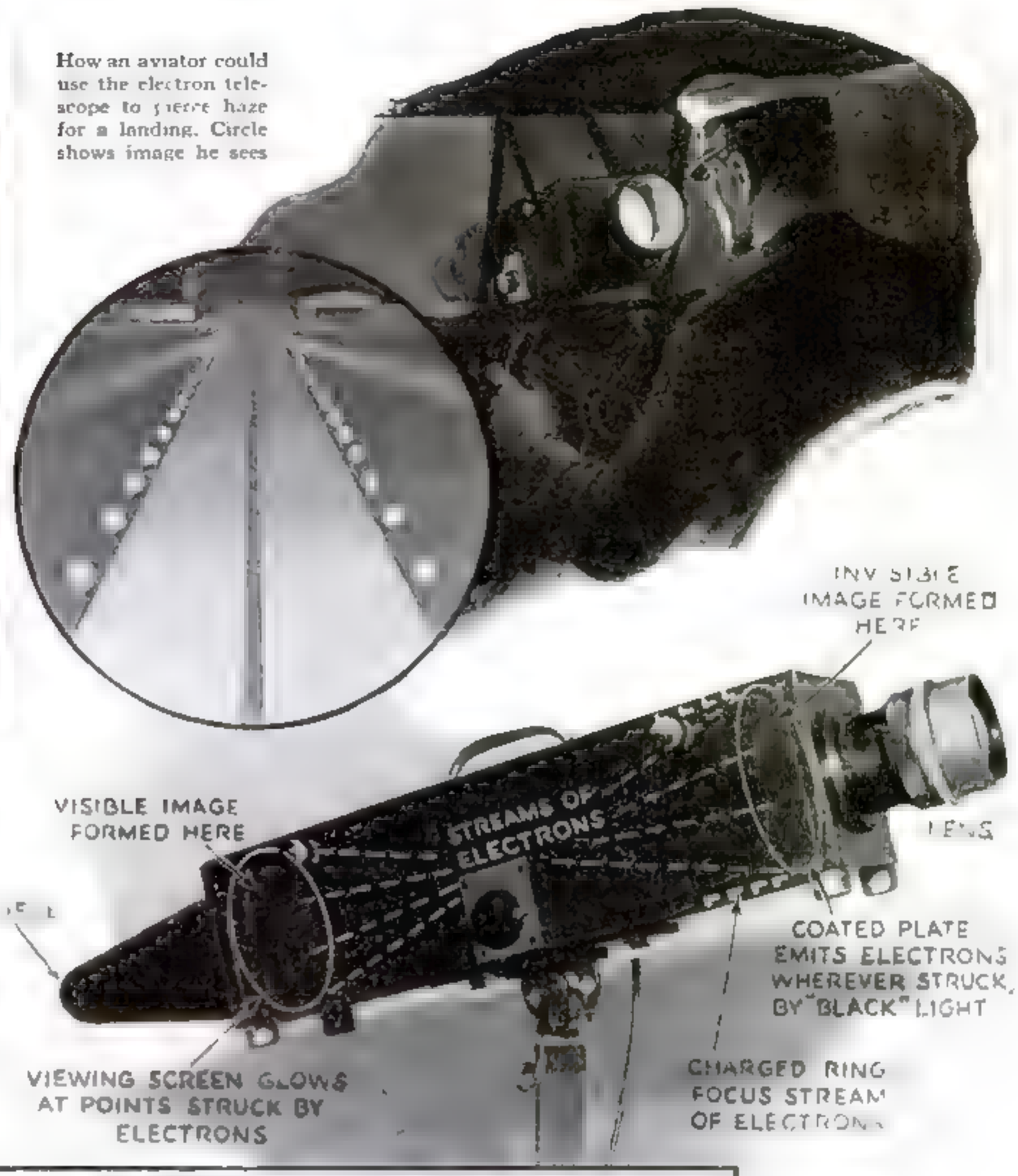
"How about landing?" I inquired. "Especially the first. Do you get the jitters?"

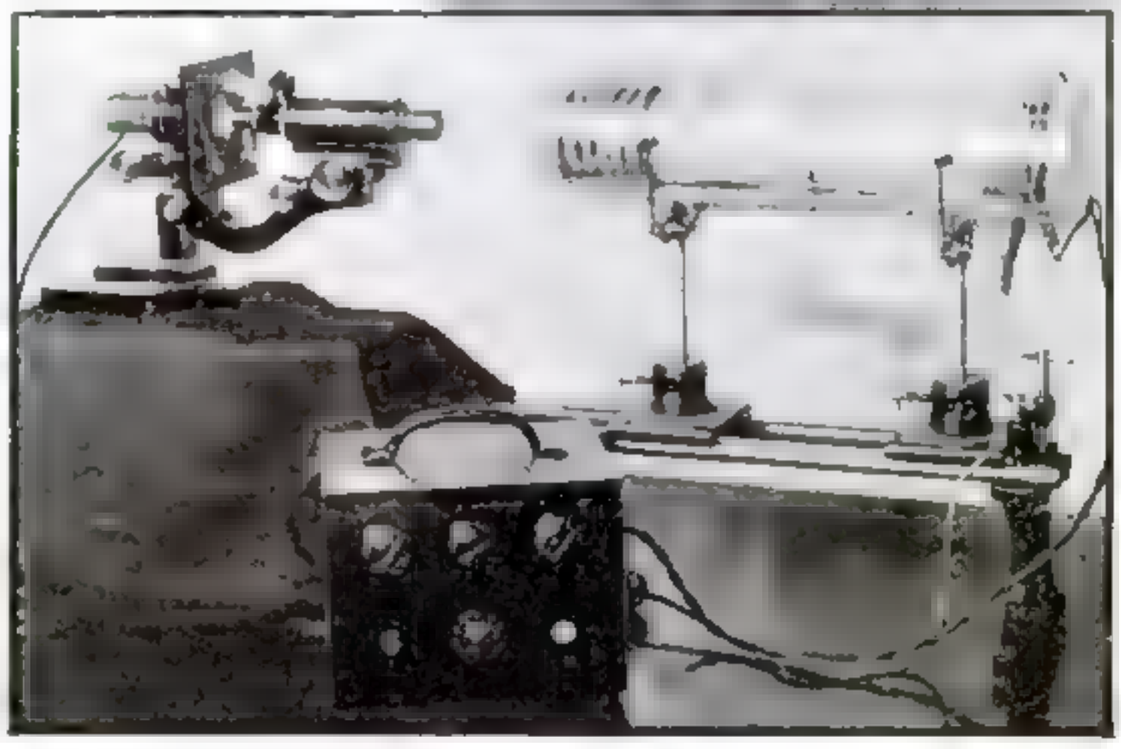
"Sure," he confessed, "but not because I'm afraid I might run into the ground. What I really fear is that I'll make some mistake and the instructor's voice will boom through the interphone, giving me the dickens. When I get really close to the ground, say *(Continued on page 122)*

Future pilots covering the fuselage of a damaged plane in the school shops

Black-Light Telescope Sees in the Dark

A motion-picture scene as it appears when projected on the viewing screen of the new instrument by infra-red light. Note how much of the detail has been preserved





This close-up view of the electron telescope, shows how an invisible image formed by infra-red rays is made visible on the viewing screen

At the left, the instrument is applied to a microscope for the study of germs under infra-red rays. In this view, the outer case is removed

SEEING in the dark is literally made possible by an amazing "electron telescope" just perfected by Dr. V. K. Zworykin of the Radio Corporation of America. Startling applications result from its ability to transform invisible rays of infra-red or "black" light, emitted by unseen objects, into visible images of the objects

Pointed into haze that ordinary light cannot penetrate, the electron telescope will reveal the landmarks of a dangerous passage so that a ship can navigate it in safety or pick up the lights and outlines of an airport for a plane that is groping for a landing. Haze is no barrier to the infra-red rays that the telescope uses.

On a pitch-black night, a beam of infra-red rays may be projected artificially at a distant target, and an observer using the electron telescope will be able to see objects struck by the beams as plainly as by day. An ordinary searchlight emits infra-red rays, and dark screens have been made that will transmit these rays alone, withholding all visible light. Thus, observations could be made in absolute secrecy—a possibility of untold military significance.

In an entirely different field, the new instrument will come to the aid of the biologist. Applied to a microscope, it will enable an observer to study germs and tissue by infra-red light, bringing out details unseen under ordinary illumination, and obviating the use of intense light or stains that often kill the specimens. Thus the electron telescope will bring the natural development of hitherto baffling cells within the range of human vision.

The instrument that makes all this possible is essentially a television transmitter and receiver in one. Its function is to form an image from infra-red rays, and to transform this invisible picture, by television principles, into a second image consisting of visible light. The compact apparatus that accomplishes the feat is housed in a box like that of a street photographer's camera.

A standard camera lens forms the original image, upon a metal plate within a large vacuum tube. Wherever infra-red rays strike the plate, a thin coating of chemically treated silver emits electrons. Just as a lens focuses light rays, charged electric rings focus the streams of electrons upon a fluorescent screen, resembling an X-ray viewing screen. The screen glows with a greenish light wherever the electrified particles strike it, and the visible image is thus produced. The definition is said to be comparable to that obtained by photography.

In a recent demonstration before a group of scientists, motion pictures were viewed through the electron telescope. Interposed in the projector beam, a filter of dark glass allowed only infra-red rays to pass, cutting off all visible light, without impairing the clarity of the images on the viewing screen. The device is also sensitive to visible light.

Interesting experimental devices, such as the "noctovisor" of John L. Baird, British television experimenter, have been developed previously in attempts to find a practical means of seeing in the dark. What distinguishes the new electron telescope from apparatus hitherto tried out, however, is its novel scheme of focusing electrons like light beams, dispensing at one stroke with all moving parts and with cumbersome scanning devices. Thus it turns what might otherwise be a laboratory toy into a compact instrument for immediate practical use.

Sand hogs at work in the tunnel as the big shield pushes ahead of them

THE TUBE
A section of the tunnel wall set up above ground to test a model of the erector arm used to place ring segments

GLASS-LINED

River Tunnel *Built in Record Time*

"HOLED THROUGH" months ahead of schedule and seventy-five percent completed at this writing, the new Midtown Hudson Tunnel linking New York City and New Jersey reflects the striking progress that has been made in engineering methods in the last few years. Mechanical innovations employed to speed the construction of New York's latest vehicular tube are declared to mark a major advance in the art of tunneling.

A new invention, a mighty hydraulic wrench, helped sand hogs toiling far below the bed of the Hudson River to shatter long-standing records in erecting the twenty-two-ton iron rings that form the backbone of the tunnel. Each of these rings is composed of fourteen curved segments, bolted together, and the assembled ring is bolted to the last preceding one as the tunnel progresses. Formerly, two husky workers strained at the end of a five-foot wrench to pull each of the nuts tight. The new hydraulic wrench eliminated this manual labor. Resembling the minute hand of a monster clock, it rode around a circular track within the tunnel, while its metal hand grasped each nut and speedily whirled it home to just the proper tension. With this potent aid, sand hogs were able to erect as much as forty-five feet of tunnel wall—eighteen rings—in a single day, as compared with a maximum of twenty-four feet when the work was done by hand.

Thanks to this device and to a host of other important, if less spectacular, refinements in mechanical technique—including an improved type of erector arm to lift the heavy segments into place, and high-speed muck conveyors that disposed of the river-bed ooze through which the tunnel was pushed—its construction is expected to set a speed record for undertakings of its type. Its scheduled opening date of January 1, 1938, may be materially advanced.

Motorists will then have a first-hand opportunity to inspect a real novelty in tunnel design—a roof of glass. Eight thousand panes of cream-colored glass will line the top of the tube and form the largest glass ceiling in the world. The novel lining is expected to save large sums that otherwise would have to be expended periodically for cleaning and repaint-

Modern Engineering Marvels, Including a Giant Hydraulic Wrench for Tightening Nuts, Help To Push New Vehicular Tube Under the Hudson River

By ALDEN P. ARMAGNAC

ing a bare concrete ceiling, like that of the Holland Tunnel which connects the two states a little farther down the river.

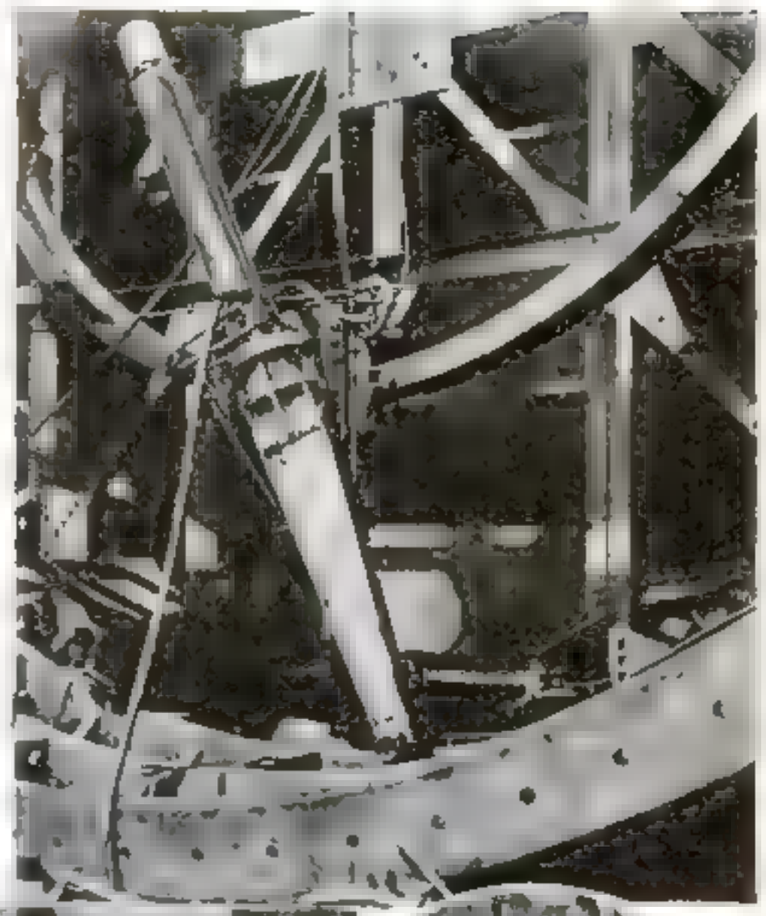
Although the walls of this earlier tunnel were tiled, its ceiling was merely of painted concrete, since its was feared that the constant jarring of traffic would shake tiles loose and cause them to fall out. The problem has now been solved by the invention of ingenious metal grippers, that hold a tile or a pane of glass with equal facility, securing it firmly to the concrete base. In the Midtown tube, these frames will hold glass panes because these have been found cheaper than ceramic tile. The glass will have a stippled surface, designed to minimize glare and to improve the efficiency of the tunnel lighting system.

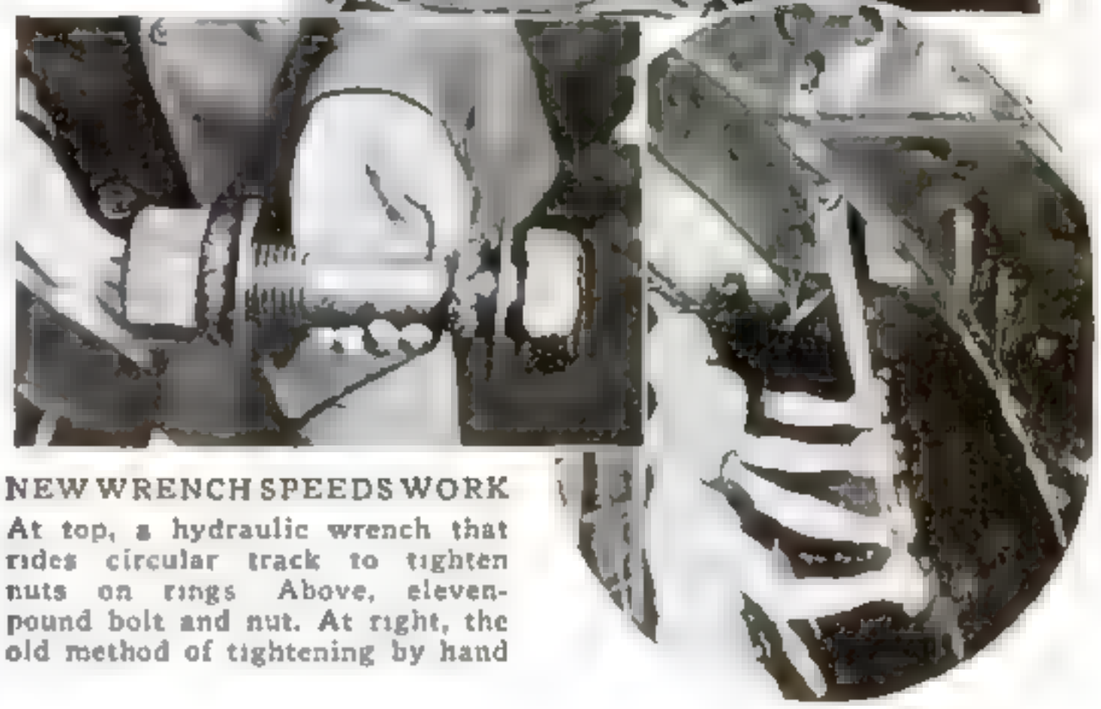
When first opened, the Midtown Hudson Tunnel will consist of a single tube carrying two lanes of traffic in opposite directions, between West Thirty-Eighth Street, in New York City, and Weehawken, N. J. Eventually, a second tube will be pushed through alongside the first, and each will then become a one-way tunnel. Funds advanced by the Public Works Administration, under Administrator Harold L. Ickes, permitted the start of the ambitious project with the construction of the first tube, which in itself will help relieve traffic congestion at the George Washington Bridge to the north and the Holland Vehicular Tunnel to the south.

Facts and figures revealed by Wharton Green, resident project engineer, show the magnitude of the undertaking. The new tunnel, passing from New York beneath the Hudson River and piercing the solid rock of the Palisades on the New Jersey shore, will measure about 8,000 feet between portals. Its thirty-one-foot diameter will permit a roadway a foot and a half wider than that of the Holland Tunnel. More than 170,000 cubic yards of rock, earth, and silt have been displaced, and 2,300 rings erected, to construct this huge shaft since ground was broken in May, 1934.

A circular metal shield, weighing 400 tons was advanced a few feet at a time by thirty hydraulic jacks of titantic power to punch a hole for the tunnel through the river bed, starting from the Jersey side. As it passed beneath a railroad, it added an amusing mishap to the annals of the tunnel, for its molelike trail upended the rails and a station platform as if an earthquake had hit them. Then, plunging down into the river ooze, it started its real work. Air pressures up to forty-five pounds to the square inch kept water out of the shaft as sand hogs toiled within the thimblelike trailing edge of the shield, erecting iron walls that consolidated their hard-won gains at every push of the giant mole. Bubbles rising to the surface of the river told of their constant peril lest a minor air leak should suddenly develop into a major "blow," or escape of air, which might shoot them through the river bed or let the river in upon them. Completion of the ringed shell of the tunnel, as it was finally holed through into the connecting shaft from the New York end, enabled the abnormal pressure to be released. As this issue goes to press, workmen are placing the concrete that will line the finished tube, and erecting the roadway that will enable motorists to cover in a few minutes a journey that took sand hogs fourteen and a half months.

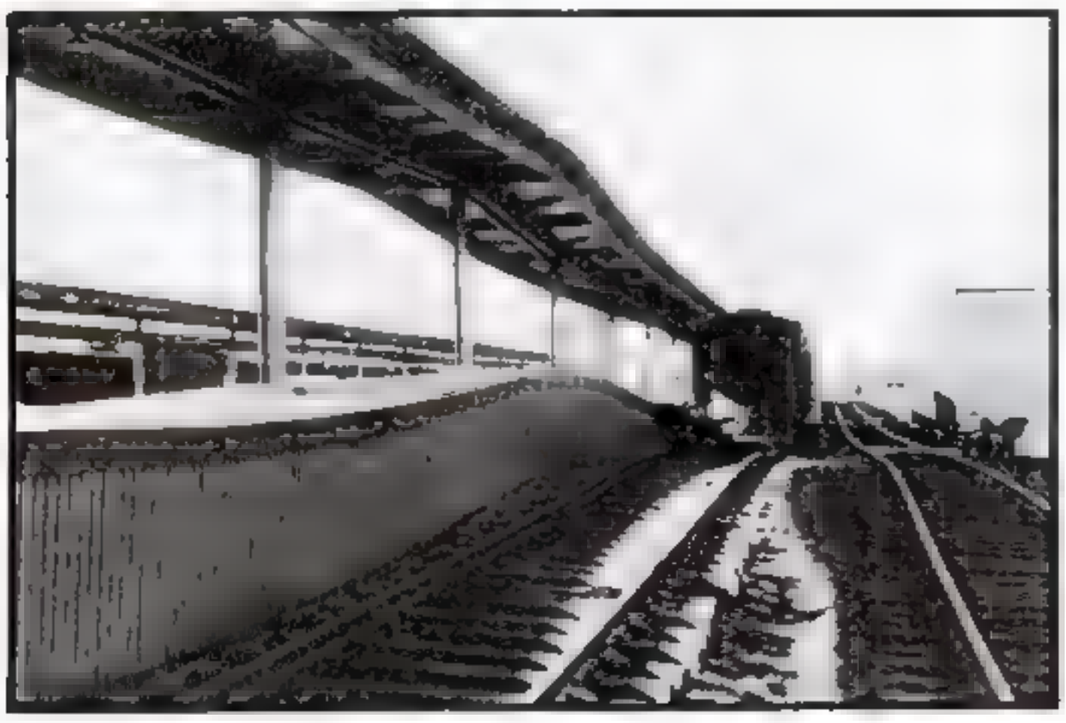
Eventually, an underground highway may link the Midtown Tunnel with a projected tube under the East River, on the opposite side of Manhattan Island, giving motorists a through route between Long Island points and New Jersey mainland.





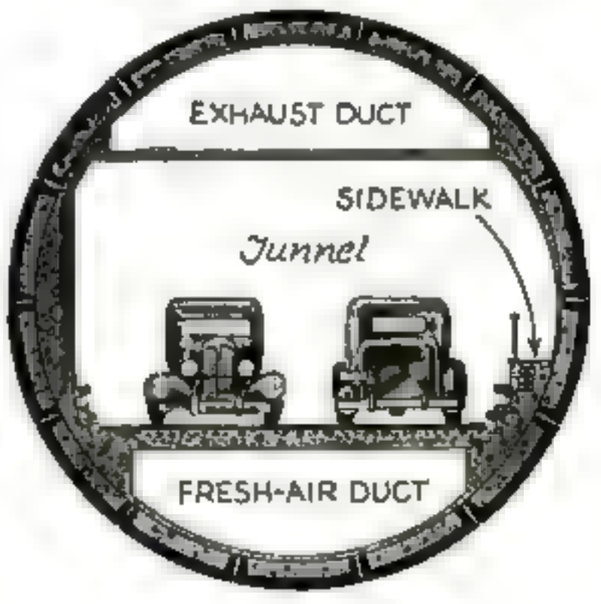
NEW WRENCH SPEEDS WORK

At top, a hydraulic wrench that rides circular track to tighten nuts on rings Above, eleven-pound bolt and nut. At right, the old method of tightening by hand



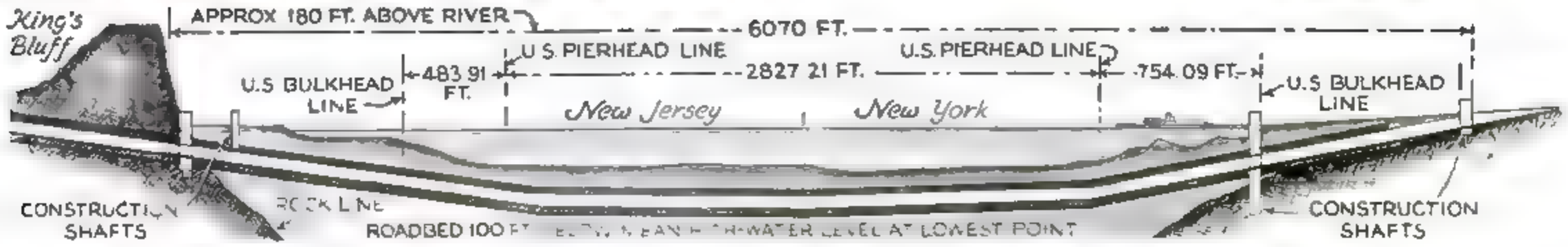
MAN-MADE MOLEHILL

Burrowing under a railroad track near the river shore, the mechanical mole raised the track and platform as shown in odd view at left



UNDERWATER HIGHWAY

Drawing at right shows cross section of tunnel. Highway is laid in a tube thirty-one feet in diameter, made by bolting together curved iron segments to form rings



Cut-away view of the bed of the Hudson River, with the new tunnel plunging under it to link the midtown section of New York City with New Jersey

World's Craziest Jobs

ADD REALISM TO MODERN MOVIES

Jerry Smith, one of Hollywood's odd-job men, spraying a horse's tail with paint to make it register well. At left, Fritz Dickie at work on his collection of bleached bones, used for atmosphere in western pictures

IN HOLLYWOOD you will find more sane people performing crazy jobs than anywhere else in the world.

Painting horses' tails, for instance. Or bleaching steer bones, breaking crockery, painting blood stains on shirts, waxing and polishing artificial fruit, painting natural flowers odd colors for the camera, spinning giant spider webs, grunting and groaning and shrieking in imitation of birds and animals, chasing bedbugs, and submitting to snake bites.

No job is too queer for these behind-the-scenes workers in the City of Celluloid, for the demands of the camera and microphone are many and varied. Take horses' tails. Harold Lloyd selected a fine sorrel mare to pull his wagon in "The Milky Way," but the cameraman soon registered a protest. The tail wouldn't photograph well. Cameraman, director, and the owner of the animal conferred, and a half hour later Jerry Smith found himself busy "blonding" the tail with a paint spray gun so that it might show up more clearly as it swished back and forth across the actor's face.

Occupations that would be queer in Seattle or Miami are commonplace in Hollywood. Five hundred men and women are listed in studio directories as owners of animals available for pictures at a rental ranging from five dollars to $100 daily. There are, too, men who will catch anything that lives in Southern California on short notice and deliver their victims, alive and kicking, to any studio—for a price.

Not long ago, a studio demanded delivery within forty-eight hours of 320 grasshoppers, 225 large red roaches, 160 bedbugs, 430 spiders, sixty small roaches, and twenty-four black beetles. The firm receiving the request devised ways and means of filling the order. A scout found the bedbugs in a Chinese lodging house, and bought them by exchanging two new cots and a sum of money for two old beds. Five experienced bug men took to the fields near Los Angeles and netted the grasshoppers during a two-day chase. Spiders were plucked from thick hedges. The basement of a large office building yielded up the cockroaches.

"This," declared one of the bug chasers, "was the craziest order we ever got. Well, nearly the craziest. Sometimes a studio wants some one to be bitten by a rattler. For fifty bucks a bite, I'll let 'em strike. When they're cold, they don't really bite. Anyway, I wear boots, so it's easy money for just letting them try their fangs out."

As I toured Hollywood, seeking out the world's queerest jobs and talking with the men who perform these unusual tasks, I found a score of them earning their daily bread at things which look silly, but which have very definite values.

For instance, on the roof of a great stage at the Paramount studio, I discovered Fritz Dickie examining the bleached bones of a dozen steers which had succumbed to the slaughterhouse hammer a few weeks before. It is Dickie's job to collect old bones and bleach them for use in western pictures. For several years he made regular trips to the Southern California

With paint, blowtorch, and lampblack, this painter is giving a movie set the appearance of being old and worn

SQUEAK ELIMINATOR. C. W. Hutchinson, a carpenter, testing the floor of a set for squeaks that might spoil the sound recording

Painting horses' tails, spinning spider webs, and weighing chorus girls are only a few of Hollywood's odd chores

By JOHN E. LODGE

A MAGIC BOX. From this mysterious cabinet Irving Sindler, head property man for the Samuel Goldwyn studio, can produce anything from a needle and thread to a champagne popper. He is holding the latter

A HUMAN SPIDER SPINNING WEBS

Using an electric fan fitted with a container of liquid rubber, Harry Thompson spins realistic "cobwebs." He can fill a "haunted house" with spider webs in a few minutes

SHOOTING STARS IN COLORS

George Horrall has a new studio job, making photographs of movie stars in color. Here he is getting a shot of Shirley Temple

deserts seeking old bones, but the desert no longer takes its historic toll of cattle, so he now obtains them from slaughter-houses, and does his own bleaching.

Then, there's the squeak eliminator. This is not a mechanical device, but a carpenter named Robert Green. He ferrets out squeaks on each new set by pushing a roller over the floor. Out come his hammer and nails, and he kills the squeak before some actor releases the noise and spoils a scene. Green has found and destroyed hundreds of squeaks, any one of which might have cost a month's wages in lost time and spoiled film.

All glass used on a motion-picture set must be perfectly transparent, else the camera will pick up reflections and register the dirt. Not long ago, an actress walked through a plate-glass show window and fractured her nose. Immediately, Charles Beauchamp got a new job. On every set involving the use of glass, it is his duty to stretch strips of black tape in the form of crosses over all glass until the camera begins to reel. No further glass accidents have been reported in that studio.

"Mirror spoiler" is the unusual assignment given William Witt whenever his studio films a picture requiring the use of mirrors on the set. And with good reason, for mirrors, no matter how carefully placed, pick up light and bounce it back into the camera. In order to kill this halation, Witt coats all mirrors with a thin layer of liquid wax.

Whereas it is one man's job to save properties from damage, it is another's to do a classy job of wrecking things. Arthur Camp breaks crockery and statuary so effectively that whenever a scene is shot in which a fight or storm supposedly has taken place, he smashes a score or more of plates, statues, and vases to small bits. Scattered around the set, these fragments add to the appearance of confusion.

Specialists get these odd jobs. A man who is found to do one thing well gets the call for similar tasks whenever the need arises. Aging, for instance. Everything appearing in a set, such as a British street whose houses are supposed to have been built a hundred years ago, or an old house, must be given the appearance of age.

Carpenters, equipped with blowtorches, gray paint, and lampblack, burn off fresh paint and "dirty" the walls in short order. The set itself aged, property men bring in the smaller articles, such as chairs and pictures. These, too, must give the appearance of long, continuous use. Pat Delaney has aged more small objects than any other Hollywood property man. He applies dark shellac and an assortment of paints to remove the newness from these things. Delaney learned his job while reproducing antique furniture. Then he went to Hollywood and landed his unusual job with a studio.

Suppose the director calls for a cobweb-

Twins of the screen—Joe Morrison, actor, and the "stand-in" who takes his place during the long hours of preparation before scenes are made

filled haunted house. After the set has been aged, in walks a human spider to spin the web. Harry Thompson recently devised a novel machine with which he can fill a large room with interlaced webs in ten minutes. This consists of an electric fan, with a container of liquid rubber fitted directly in front of the blades. Centrifugal force ejects a tiny thread and the air current blows it out.

It is the ambition of every director to see his production and name on the screen, and of every actor to have his face registering comedy or tragedy in all the theaters of the land. Yet, there is in Hollywood one man who has directed thousands of pictures, not one foot of which ever reached the public; and there are scores of actors of whom a camera has never ground out a scene.

The gentleman who has filmed so many scenes, all of which are destined from the beginning for the scrap can, is a test director. To him come all the principal players of sixty feature pictures produced annually by the studio where he is employed. He tests them to make sure their make-up is of the proper color and tone, and properly applied; that they have selected suitable costumes; and that they read their lines in accord with the "mood" selected for each character. Those who "pass" are selected for the picture, and the test film is discarded.

Actors you never see are known as "stand-ins." Paid moderate salaries, these men and women are chosen because each resembles in size and features some high-salaried star. The "stand-in" appears for long hours before the camera, sitting, standing, and walking, while the cameraman studies angles and makes adjustments. At the last moment, when all is ready, the star, untired by these tedious preliminaries, appears and plays the scene.

Seldom do you see a natural flower or blossom in a picture. Usually, even the color is not actually that of its natural prototype. For instance, Roy L. Hollis specializes in creating beautiful artificial flowers and trees, making them of lacquer, bamboo, copper, and paper. Not long ago, Hollis produced in a few days 10,000 branches of peach blossoms, each consisting of wood-fiber flowers tied to natural wood. On another occasion, he made 100 apple blossoms, each five feet wide and containing five paper petals. Hollis has completed as many as 720,000 flowers and branches for a single movie production. Because of the artistic appearance and long life of artificial flowers, less than one tenth of all blooms seen on the screen is provided by nature.

What happens to real flowers used in the movies, before the director shoots the scene? Many flowers do not photograph well in their natural color; so, at one studio, Bill Tait not only keeps them fresh, but changes the color to suit varying conditions of background and lighting. Using an ordinary spray gun and special dyes, Tait dyes roses blue and lilies purple or green, and performs other feats of magic while the camera waits.

Like flowers, fruit does not register naturally, nor does it remain fresh longer than a few hours under the hot lights of a movie stage. Here again, artificial varieties are resorted to, and these must be given the proper sheen by a "fruit polisher" who applies glycerin and liquid wax. Otherwise, apples, oranges, and grapes would look dull and unappetizing.

Probably no studio worker has his ingenuity taxed more frequently than the property man. He may be called upon one minute to supply an old champagne bottle, only to have the director follow this order with a demand for a cowbell. Irving Sindler, head property man at the Samuel Goldwyn studio, has developed several portable boxes which he keeps on the set near the cameras. From these he can produce anything from a door bell (ready to ring), to fog-making apparatus, fly swatters, bottles, brooms, and popguns. One box is equipped with a mirror for use as an open "dressing room," to touch up a star's make-up.

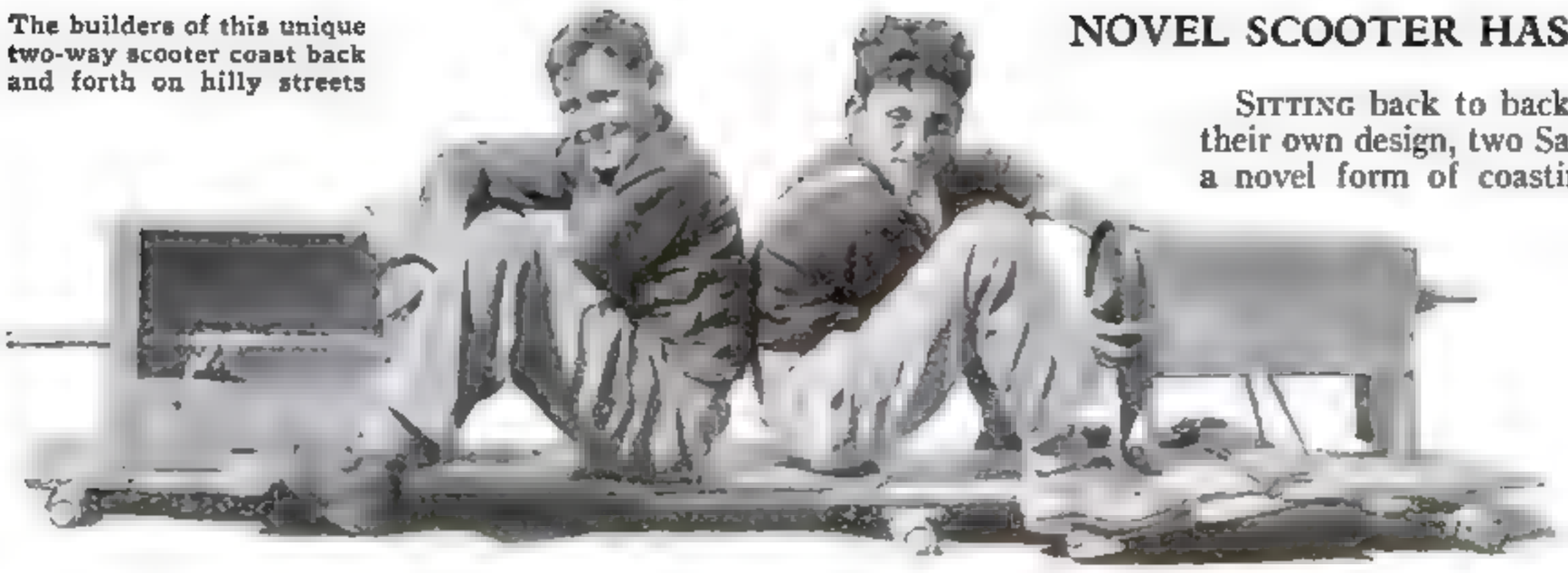
Each studio has its guardian of the silver. Not tableware, as you might suspect, but large ingots recovered from developing solutions. Silver salts are washed off the film in the process of developing, and the water is run into large vats. There, by an electrolytic process, the silver is captured in *(Continued on page 126)*

Painting the lily is the novel job held by Bill Tait, shown below changing the color of flowers with a common spray gun

Fred Harris, location director for Paramount with a map of Southern California showing the areas that duplicate the scenery of any given part of the world. At right, Pat Delaney applying shellac and paint to miniature portraits to make them look like antiques

Hollywood's standing army—members of the Military Picture Players, a unique organization which supplies trained soldiers for military and historical movies. Trained to obey commands in nine languages, these warriors impersonate troops of any nation or period. In this scene they are German

NOVEL SCOOTER HAS TWO FRONT ENDS



The builders of this unique two-way scooter coast back and forth on hilly streets

SITTING back to back aboard a two-way scooter of their own design, two San Francisco, Calif., boys enjoy a novel form of coasting on the city's hilly streets. One boy steers the odd vehicle as it rumbles to the bottom of a hill and coasts part of the way up another. Then, without turning the six-wheeled car around, the second boy takes the other steering wheel to guide the scooter back down the slope.

NOTCHES IN CORN KNIFE PICK UP FALLEN STALKS

CORN harvesting is made easier by a two-purpose knife just introduced. The tool has two "hooks" notched out of the dull edge of the blade, one at the end and one in the middle; with these the farmer pulls up leaning or fallen corn stalks to the right position for cutting with the sharp side of the blade. The hook at the end of the blade is used for handling stalks that have fallen flat, while the one in the middle picks up those that are leaning over. The device not only eliminates the necessity for continuous stooping and bending, but also is said to speed up the work of harvesting.

AMATEURS USE NEW-TYPE DIVING MASK

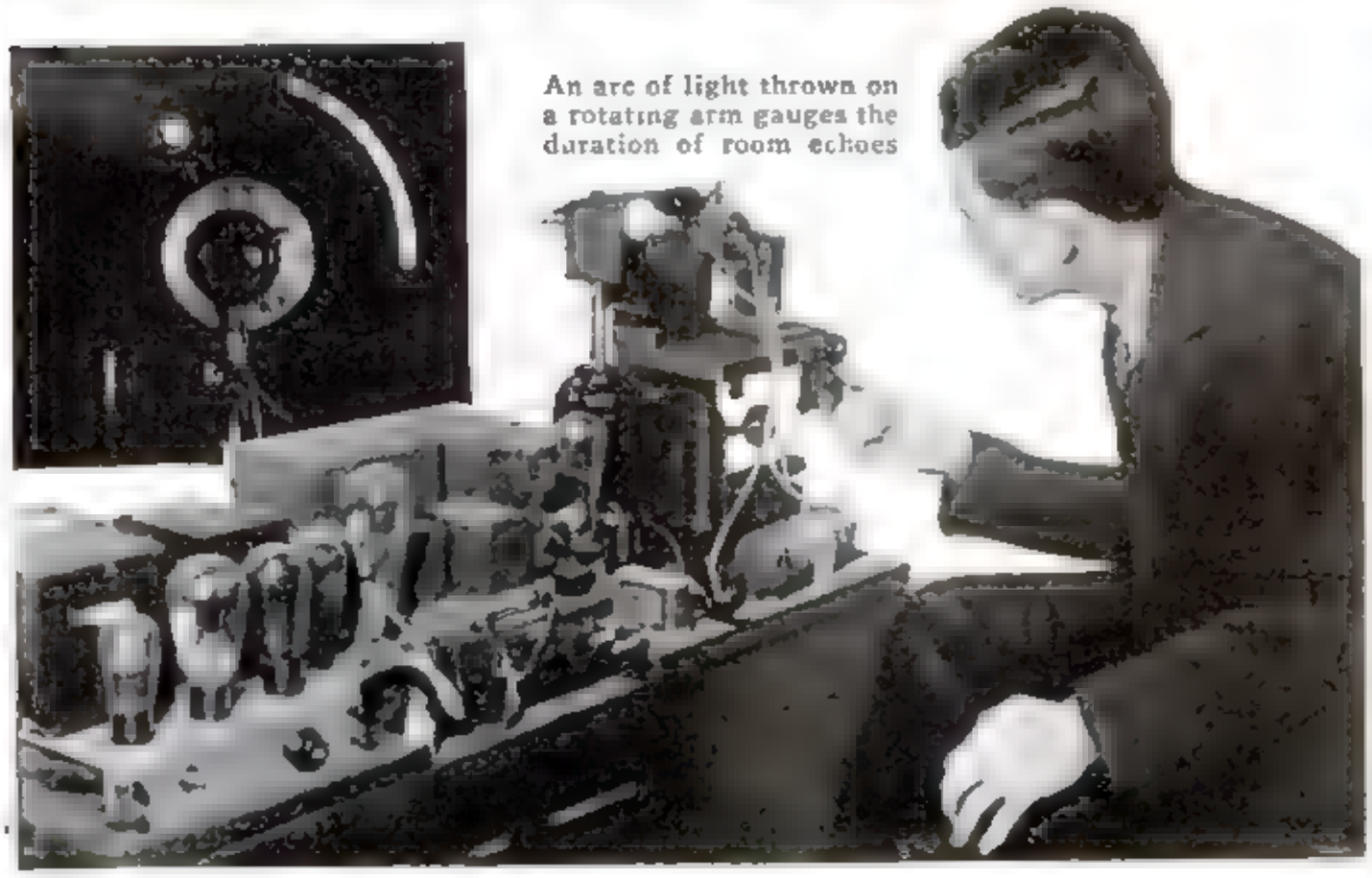
MEMBERS of a newly founded French "underwater" club use a novel type of diving outfit. Transparent, water-tight masks cover the face and are held in place by straps fastened about the head. When submerged, the divers breathe through long rubber tubes, the ends of which are held above the surface by metal clamps attached to floating rings resembling life preservers. Thus, the wearers can move about under the water for long periods of time. The club was formed by a group of people interested in diving and underwater exploration as an enjoyable hobby and form of exercise for their spare time.

A party of amateur divers in a bathing pool in Paris, France. They are wearing transparent, water-tight masks

A floating ring resembling a life preserver supports an air tube through which the diver draws breath

ECHOES GAUGED BY WHIRLING LIGHT

ECHOES of artificial thunder discharged from the loudspeaker of a new sound apparatus are accurately measured by means of a whirling neon light to test the acoustics of a room. Both the clap of "thunder" and its various reverberations from walls and ceiling are picked up by a sensitive microphone, amplified, and made to flash a neon bulb which spins on a rotating arm. Room echoes are measured by the length of the lighted arc made by the whirling lamp. The device will be used in correcting the acoustics of large auditoriums, court rooms, lecture halls, and classrooms in schools and universities.

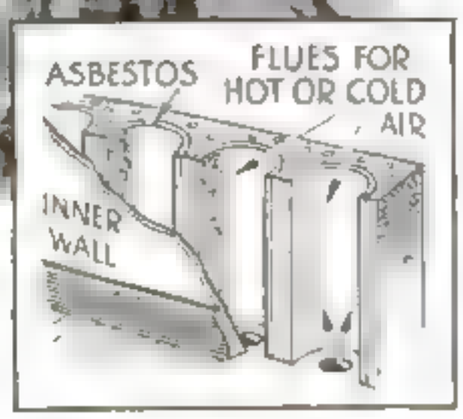


An arc of light thrown on a rotating arm gauges the duration of room echoes

MOVING SUPPORT GUIDES BLADES ON OILSTONE

A CIRCULAR oilstone with an ingenious guide makes it easy to hold chisels, plane blades, and other bevel-edged tools at the correct angle during sharpening. Grasped in a special holder, the tool is moved back and forth over the stone, while a ball-bearing post beneath the holder rides along the surface of a disk-shaped guiding table. The proper angle is maintained regardless of pressure applied.

PIPES IN WALLS HEAT OR COOL NOVEL CONCRETE HOUSE



Asbestos flues set in the walls of the house before concrete was poured. Inset shows how pipes are placed in the walls

In oval, exterior of house after concrete was applied. At top, the finished house with stucco coating

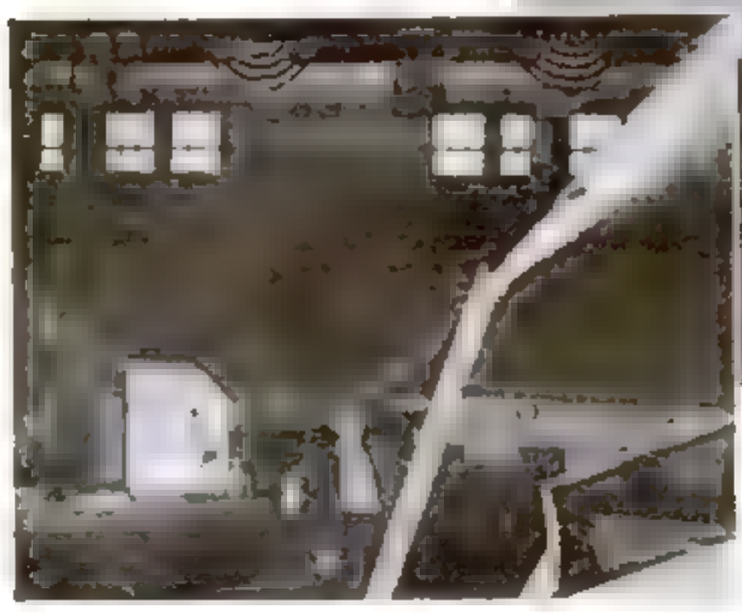
WALLS act as radiators in a concrete house erected recently in Red Bluff, Calif., as an example of a new method of building construction. Warm air from a special type of heating plant rises through half-round asbestos flues embedded in the walls, and the heat is radiated from the inner wall surfaces into the rooms. A space under the floor acts as a supply reservoir for the warm air, which may also be discharged directly into rooms through grilles. Sprays of water in the heating plant keep the air at the correct humidity, and in summer they chill the air that is blown through the flue system to cool the house. The new method of construction is said to be very economical, both in first cost and in the operation of the heating and air-conditioning plant. The inventor, who constructed the experimental house shown in the accompanying illustrations, claims that in addition to its novel heating plant the new method of construction is such that it is less likely to be damaged by the action of fire, earthquake, moisture, and termites.

HUGE LIGHTS TO EXPLORE THE UPPER AIR LEVELS

LEVELS of the atmosphere beyond the reach of balloons are now to be studied by pointing giant searchlights skyward. The rays, reflected to earth by dust and other particles, will be collected for study with mirrors like the one shown above. Observers of the Carnegie Institution hope thus to glean new facts about the density and composition of the upper air, much as astronomers learn about stars by analyzing starlight. The test beam, interrupted at a given frequency by a shutter or "light-chopper" at the source, will be recognized by observing instruments tuned to this frequency.

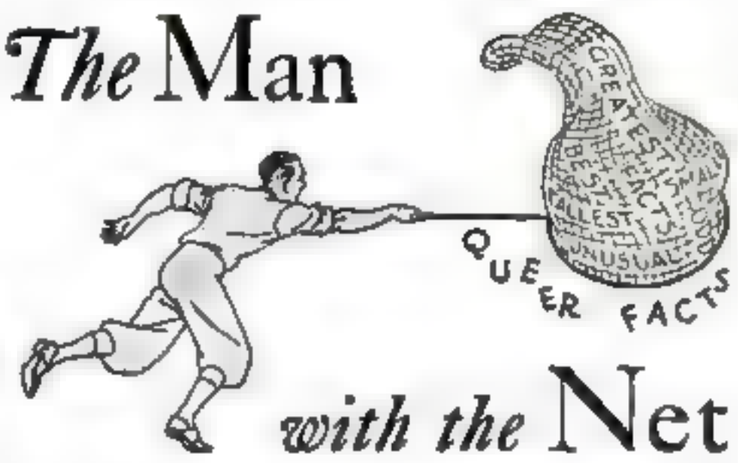
SPRAY "SNOW" ON INDOOR SKI JUMP

STARTING near the roof of a huge indoor arena, ski jumpers whizzed into space from what was called the first indoor ski jump in the world, erected recently for a winter-sports carnival at Boston, Mass. Tons of "snow" covered the slide, which was 200 feet long and seventy-five feet high. To provide the best possible sliding surface, a "snow machine" ground up tons of ice into snowlike powder and sprayed it onto the ski course. A large air-conditioning system maintained a low temperature to keep the snow and ice from melting.



A 200-foot ski slide erected inside a large indoor arena. At the left, the "snow machine" spraying powdered ice onto the slope of the man-made course

The Man with the Net



BURGLARIES *occur most frequently in cool weather; murders in hot weather.*

NINETY PERCENT *of the storms in the United States pass out to sea within a radius of 300 miles of Plymouth Rock.*

BRAZIL NUTS *are not eaten in Brazil.*

RED HAIR *is more common in Scotland than in any other country in the world.*

ENERGY *produced by a person speaking for five years would light a twenty-five-watt electric lamp for only one minute.*

GREEN LIGHT *from luminous mushrooms found in Australia is bright enough to illuminate a page of type.*

SPIDERS *have taste organs on their legs.*

ALABAMA *has the fewest automobiles in proportion to population of any state in the Union.*

WHITE-SHELLED EGGS *come from chickens of Mediterranean origin; brown-shelled eggs from breeds developed in America.*

PEANUTS *are not nuts.*

CELERY *grows wild in England.*

THERE *are twice as many licensed pilots in America as licensed planes.*

COLORADO'S *lowest land is 3,340 feet above sea level.*

PELICANS *move their wings in unison when in flight, keeping in time with the leader.*

NAVAHO INDIANS *refer to a motor cycle by using a native word meaning "son of an automobile."*

TEA *has 2,000 blends.*

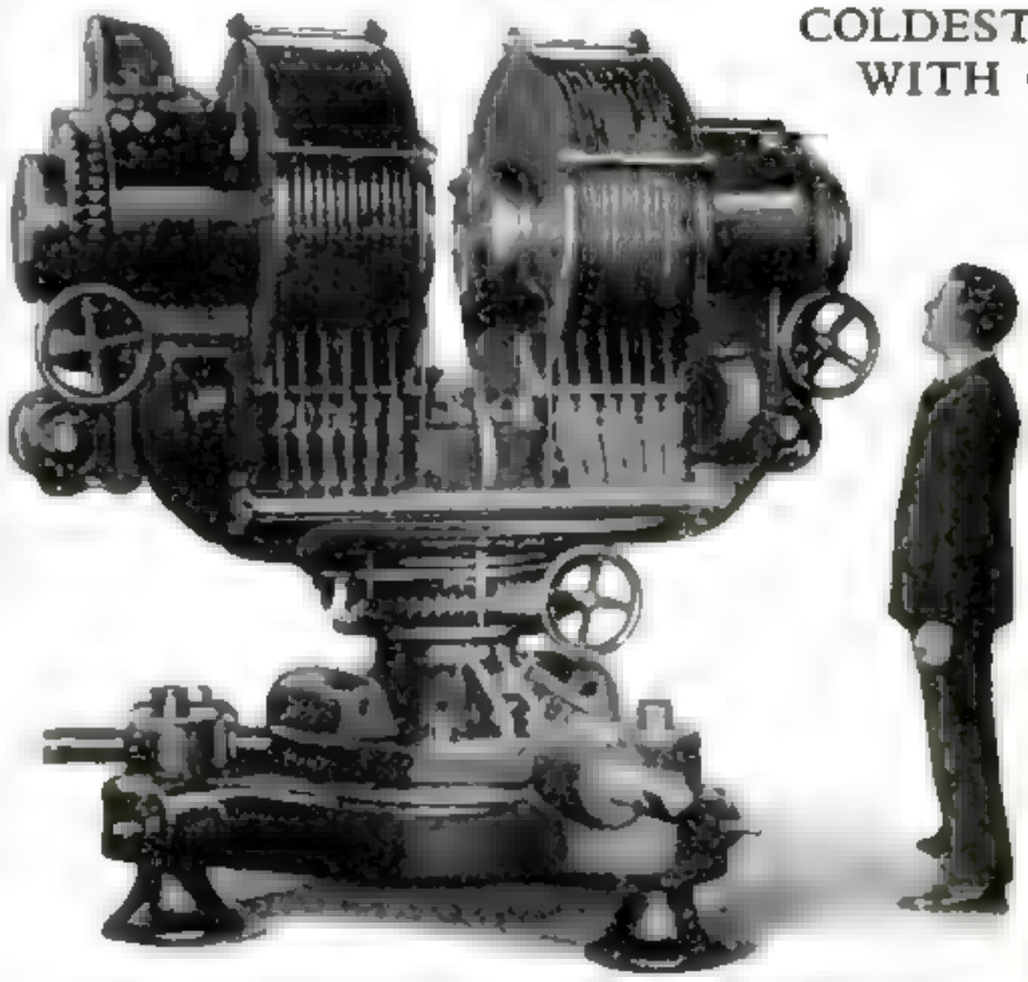
DOGS *deliver mail to French soldiers stationed high in the Alps.*

MIRROR MAGNIFIES SKIN BLEMISHES

SMALL skin blemishes are detected by a giant enlarging mirror in use in a London beauty shop. Light from a powerful electric lamp is diffused through a circular glass screen onto the face of a customer. A concave mirror in the center of the illuminated screen reflects and magnifies images of portions of the face so that minute skin defects hard to find with the naked eye are easily discovered. With this aid, beauty-shop attendants can point out defects that need treatment, and also show the results that have been obtained.

Beauty-shop patron examining her own skin with enlarging mirror

COLDEST COLD PRODUCED WITH GIANT MAGNET

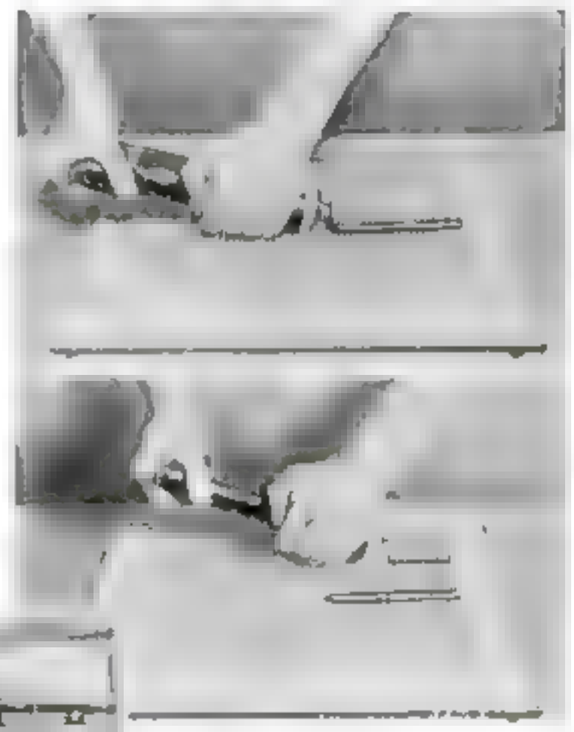


Electromagnet used to produce lowest recorded temperature

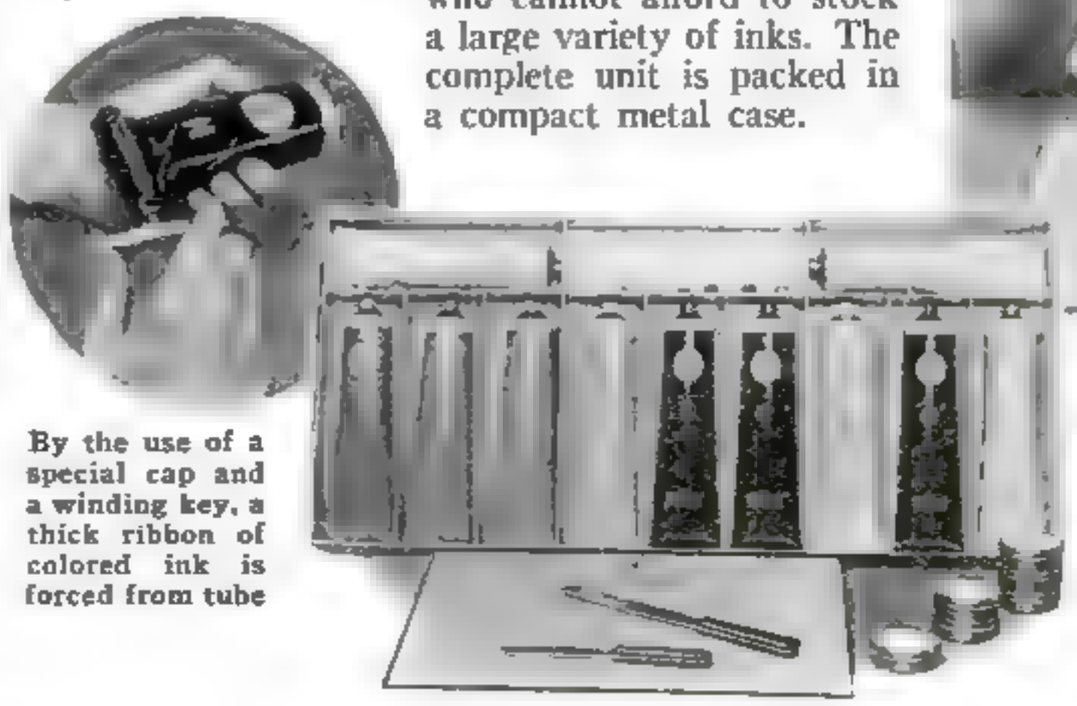
WITH the aid of one of the world's largest electromagnets, the coldest temperature on record has just been produced at the University of Leyden, Holland. The new mark is within three one-hundredths of a degree F. of absolute zero, the point at which a body contains no heat. To attain it, experimenters chilled a salt, potassium chromium alum, with liquid helium and then subjected it repeatedly to the giant magnet's field. The salt became warmer when magnetized, the helium extracted this heat, and the salt fell lower in temperature each time the magnet was shut off.

KIT MATCHES COLORS FOR PRINTING

COLORED printing inks can be mixed accurately to produce any shade desired, by the use of an ingeniously designed ink-matching kit now available. The user squeezes ribbons of ink onto a plate-glass mixing slab from tubes containing basic colors, following directions on a color chart and measuring the correct amount of each color by means of a graduated measuring sheet placed under the transparent slab. He then blends the colors with a mixing knife. The outfit is designed for job printers who cannot afford to stock a large variety of inks. The complete unit is packed in a compact metal case.



Above, squeezing measured amounts of ink on a glass slab over a graduated measuring sheet, for mixing. At the left is shown the complete matching kit and its container



By the use of a special cap and a winding key, a thick ribbon of colored ink is forced from tube

GIANT HOTHOUSE COVERS HILLSIDE

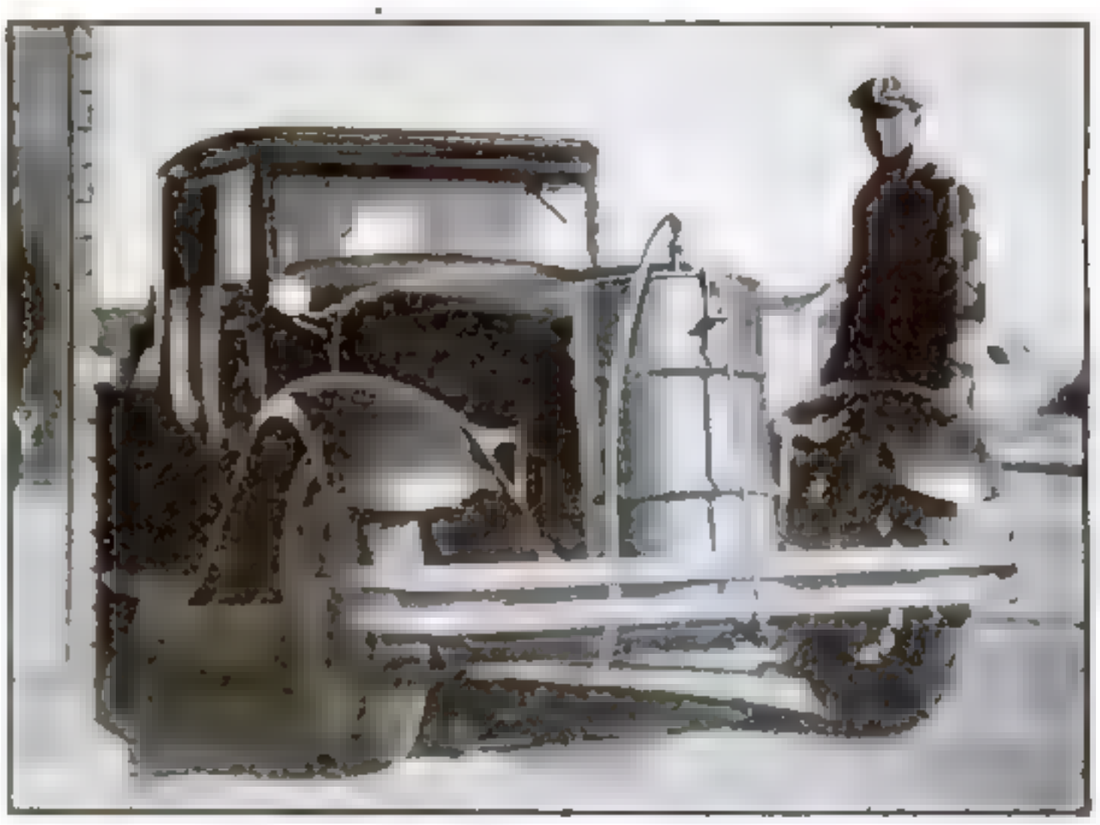
SPRAWLING beneath the ruins of an ancient hilltop castle, a huge greenhouse under construction near the shore of the Black Sea, in Southern Russia, half circles the hill and extends up the steep slope in a series of giant steps. Located in a citrous-fruit district, the mammoth hothouse accommodates an entire grove of lemon trees. Its novel construction in tiers on the southern slopes of the hill enables it to take full advantage of the rays of the sun. Lemon trees cultivated in this manner are said to bear fruit all the year around. The subtropical orchards and gardens of the Caucasus are being extensively developed for the culture of citrous fruits.

Built in tiers on the slopes of a hill, this huge greenhouse covers a lemon grove that bears fruit all year

Open telephone booth lined with sound-absorbent panels

NOISEPROOF PHONE BOOTH HAS NO DOOR

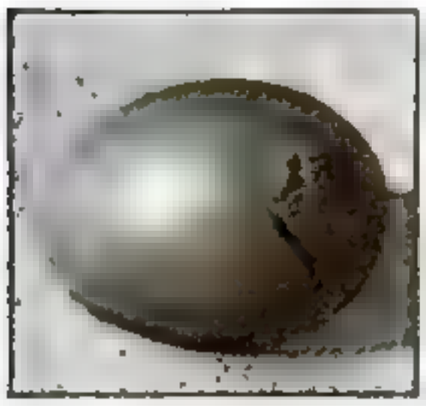
BASED on the principle of absorbing sound rather than blocking it, a noise-proof telephone booth recently introduced has no door and is completely open around the bottom. Perforated metal sheets lining the walls and ceiling are backed with sound-deadening balsam wool to suppress outside noises. The manufacturers claim that the booth may be used in subways, steel mills, machine shops, and other noisy locations where telephone conversation in ordinary closed wooden booths is difficult.



MOTORIST RIGS MAKESHIFT RADIATOR

WHEN an accident wrecked the radiator of his car, a motorist in the sparsely settled Black Hills region of South Dakota improvised a new one in order to run his auto to the nearest repair shop, 230 miles away. He adopted the ingenious method of clamping an empty oil drum on the front bumper, filling it with water, and connecting it to the engine's circulation system.

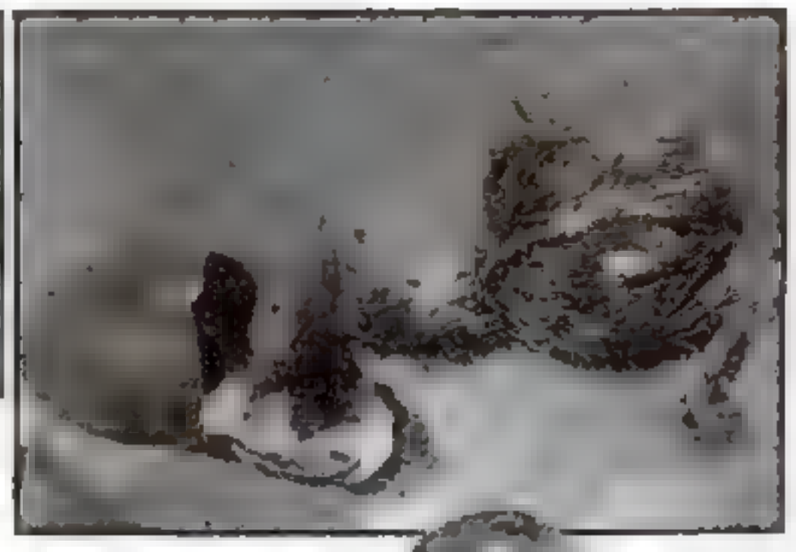
CAMERA CATCHES PHEASANT CHICK'S COMING-OUT PARTY



1 The first crack appears as the chick starts its breaking out

2 Its eyes still closed, the young bird struggles to free itself from its prison

3 A spasmodic twist throws the baby pheasant out of the shell. Note the position of the body

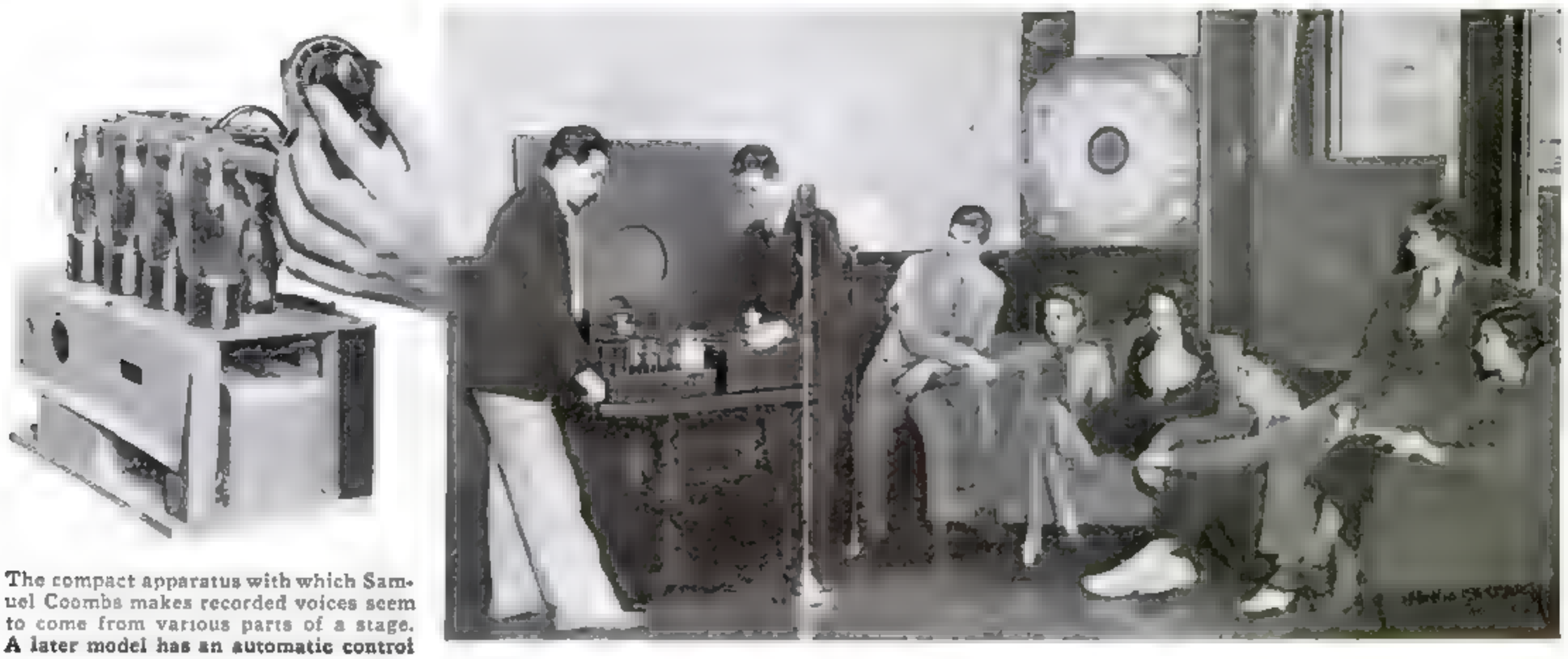


4 A slow stretch gives the bird its natural shape

5 The same chick photographed a week after hatching from the egg

WATCHFUL as a mother bird over its nest, a German nature photographer stood guard for weeks to catch a pheasant emerging from its egg. His patience was rewarded by the remarkable set of photographs reproduced here, which are believed to be the first of their kind to show the birth of this game bird. The initial view shows how quickly he got his camera into action, for the shell of the egg had hardly begun to crack as he snapped the picture. Succeeding snapshots, taken in rapid-fire succession, show how the young bird freed itself. A picture of the same chick a week later completed the unusual series of this nature study.

Student Makes Phonograph Throw Its Voice



The compact apparatus with which Samuel Coombs makes recorded voices seem to come from various parts of a stage. A later model has an automatic control

Coombs (second from left) amuses students with tricks in "controlled sound" from a phonograph

BY SUPPLYING music for dances and entertainments with sound equipment of his own construction, Samuel Coombs, Columbia University senior, has been paying his way through college and obtaining funds to experiment with novelties in sound effects. His experiments, he declares, now have brought to the point of realization a loudspeaker system that will cause the voice of a movie performer to appear to follow him about a movie screen, adding to the realism of sound movies. Trick effects on a theater stage are also possible, since voices may be projected in such a way that they appear to come from any desired part of the stage. In recording such a program, microphones are spaced at intervals across a studio and the relative volume of sound picked up by each one is registered in a "control track" upon a phonograph record. This control track may be superimposed upon the actual sound track of the program. The program is reproduced through loudspeakers occupying the same relative positions as the recording microphones, and the volume of sound from each loudspeaker is automatically varied by means of the control track thus determining the apparent source of the sound.

COLD-STORAGE LOCKERS RENTED FOR FAMILY USE

FOODS may now be stored in rented refrigeration lockers, much as valuables are kept in bank safe-deposit boxes. Householders and farmers in the Northwest buy wholesale quantities of meat, fruit, and vegetables when the supply is plentiful, and the food is frozen and placed in lockers which are kept near zero in cold-storage plants. The stored supply is later thawed out for use.

NEW GLASS BRICK HOLDS MORTAR WELL

A NEW glass brick of improved design is now available to architects and engineers who have been experimenting with glass as a building material. By a special process of enameling and sanding, the edges are given a roughened surface to which mortar adheres readily. Finished walls made of these blocks, which are laid and mortared like ordinary bricks, are said to admit light, retain heat, and deaden exterior sounds.

Improved glass brick with surface roughened by a special process to make mortar adhere to it

New street lamp which eliminates road glare. The man is holding the reflector

STREET LAMP ENDS GLARE

SHAPED like a giant acorn, a new type of street lamp reduces road glare and also prevents light from shining in the second-story windows of near-by houses. The light source is concealed within the opaque upper half of the lamp fixture so that all the rays are thrown downward onto the road. Scientifically designed reflectors distribute the light evenly over the highway surface at angles which reflect the minimum amount of light into the eyes of car drivers.

The angler can twist this bait into any shape

BAIT BENDS TO FORM VARIETY OF LURES

ANGLERS may bend a new flexible lure into numerous, different shapes to imitate a large variety of fishlike movements in the water. Made of a tough pliable material, the bait, when twisted to any desired form and pulled through the water, has a swimming action said to be exceptionally realistic. The manufacturers state tests show that only a single tail hook is needed since fish accept this lure as natural food and swallow it.

ELECTRIC "MATCH" LIGHTS PIPES OR CIGARETTES

Lifting the lighter from its holder. For lighting pipes (right), the perforated guard is rested conveniently on the rim of the pipe bowl

BECAUSE it has a long, solid heating element instead of the usual flat resistance coil, an improved electric lighter of the "pass-around" type can be used to light pipes as well as cigars and cigarettes. The base of the unit is connected to a wall plug and the handle of the "match" pressed down until the element glows. A perforated guard shields the element.

'Soapless Soap' Is New Cleaner

Preserves Cloth, Forms No Scum, and Lathers Easily

"SOAPLESS soap" is a new product of synthetic chemistry. Actually a brand-new chemical compound, it looks like soap, makes soaplike suds, and is used exactly as soap is. In fact, according to laboratory workers who have spent five years bringing it to the point of commercial production, it does everything that soap does, and does it better.

For the reported superiority of the new product over soap, in doing a cleaner and speedier washing job, a simple and interesting explanation is given. Tap water commonly contains dissolved mineral salts, whose amount determines its relative "hardness." A disadvantage of soap is that it interacts with these minerals to form an insoluble curd or scum, and no suds can be obtained until this interaction has taken place. Forming upon fabrics in the wash, the curd becomes enmeshed in the weave, dimming the colors, and shortening the life of the cloth.

"Soapless soap" also reacts with the minerals in tap water. In this case, however, the products are soluble and remain dissolved. Instead of forming an objectionable curd, the resultant compound actually helps to make suds. Thus a copious lather is instantly obtained without waste of "soap," whether the water is hard or soft, hot or cold. Instead of being cloudy, the washing solution is crystal-clear.

The suds in the beaker at left were made by "soapless soap"; in the other is shown the lather from an equal amount of ordinary soap

Using the new soapless compound to wash a fine fabric—a method that is said to retain the luster of the cloth and prolong its life

Fine fabrics washed with "soapless soap," it is said, preserve their luster and newness of appearance. Since the synthetic chemical leaves no greasy film, china and glassware washed with it, and racked without wiping or polishing, will dry brilliant and immaculate. A further advantage of "soapless soap" is said to be its harmlessness to finishes of all kinds.

Present-day manufacturers, like housewives of old, boil fats in a kettle with alkali and obtain a composition known, to chemists, as a mixture of the salts of fatty acids; to laymen, as soap. Abandoning this simple procedure, experimenters tried forcing fat to combine with hydrogen under high pressure, to form new synthetic compounds. Treating these with acid and alkali, they obtained "soapless soap."

GIANT CARDS SHOW PLAY AT CHAMPIONSHIP BRIDGE MATCH

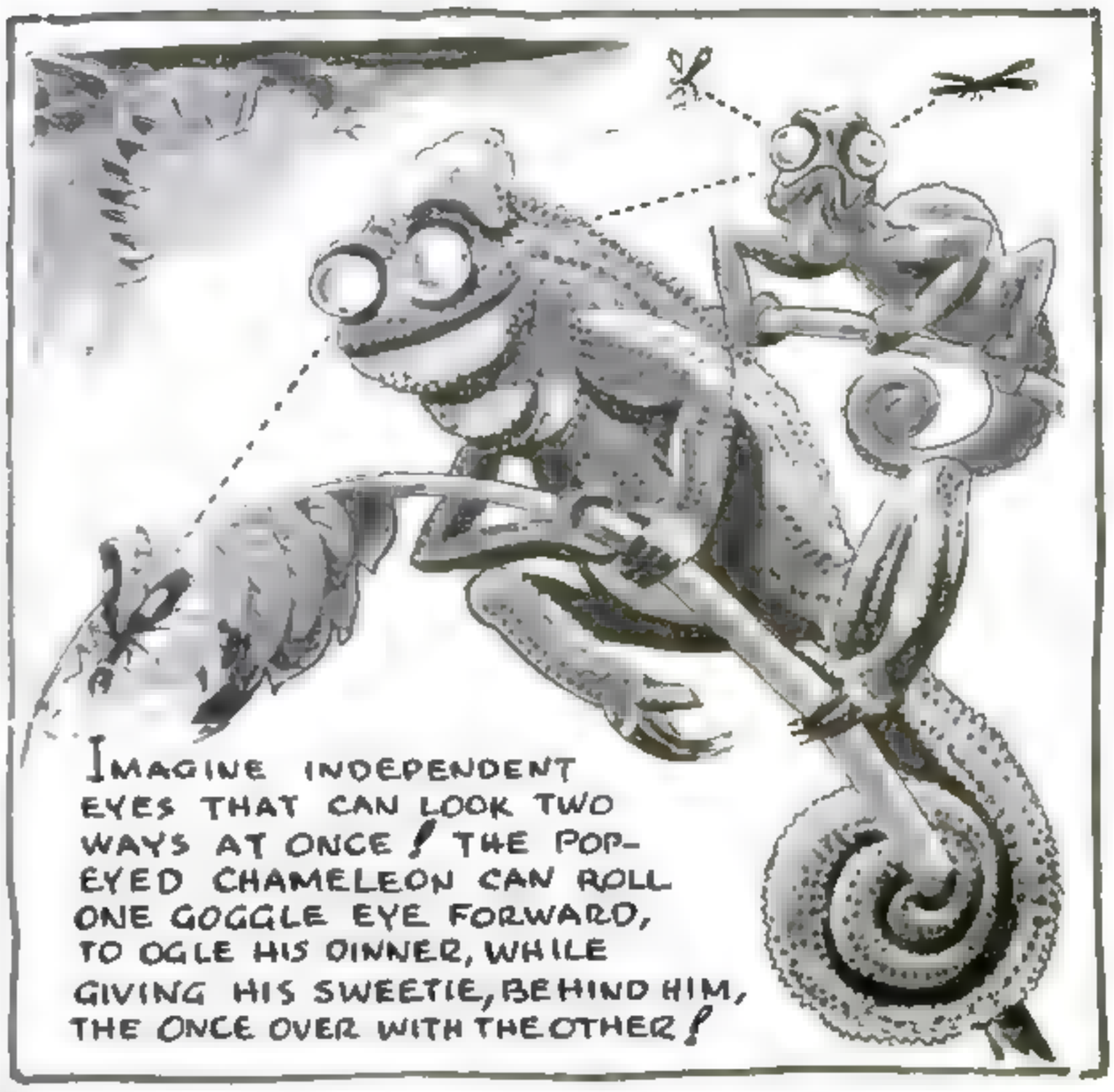
Arranged in hands, these oversize playing cards, carried by ushers, kept the audience informed of play by bridge experts

GIANT playing cards, seven feet tall and moved by attendants, kept a vast audience informed of each play at a recent international bridge match held in New York City. The experts played in a soundproof, glass inclosure while the fifty-two giant cards were arranged on a stage in groups of thirteen to represent the playing hands. The representative card was moved to the center of the stage when its counterpart had been played.

Un-Natural History

By GUS MAGER

OUR CRESTED FLYCATCHER IS POSITIVELY UNIQUE IN THAT IT HAS THE MOST REMARKABLE HABIT OF ALWAYS LINING ITS NEST WITH A SNAKE SKIN! CONSIDERING THE TERROR AND HATRED ALL BIRDS BEAR FOR SNAKES, THIS STRANGE HABIT SEEMS UNQUESTIONABLY UN-NATURAL!



IMAGINE INDEPENDENT EYES THAT CAN LOOK TWO WAYS AT ONCE! THE POP-EYED CHAMELEON CAN ROLL ONE GOGGLE EYE FORWARD, TO OGLE HIS DINNER, WHILE GIVING HIS SWEETIE, BEHIND HIM, THE ONCE OVER WITH THE OTHER!

THE WILD GOOSE'S WINGS, DURING THE MOLT, ARE AS USELESS AS AN UMBRELLA TO A FISH, THE FOWL CANNOT FLY! — AND IS ABSOLUTELY RESTRICTED, FOR SAFETY, TO THE WATER

THE WILD HOG, BABIRUSA, OF MALACCA, HAS FOUR GREAT TUSKS, THE TWO UPPER ONES CURLING UPWARD - AND BACKWARD THROUGH HOLES IN THE SNOUT. THE UPPER TUSKS HAVE BEEN KNOWN TO GROW INTO THE SKULL, CAUSING THE CREATURE'S DEATH BY ITS OWN TEETH!

DOES A SEA SERPENT SEEM IMPOSSIBLE AND UN-NATURAL? YOU'VE SEEN NOTHING YET! WHAT ABOUT THE VERY REAL GIANT SQUID, WHICH MAY REACH A LENGTH OF SIXTY OR SEVENTY FEET, AND HAS ALL OF TEN MONSTROUS SERPENTLIKE ARMS TO FRIGHTEN MARINERS WITH!

BRING on your G-men of natural history and let them try to solve the many mysteries in the realm of old Mother Nature! On second thought, maybe a Philadelphia lawyer is needed to untangle some of the natural laws that seem to have gone askew and are out of kilter. Countless inconsistencies, like the accompanying examples, make it appear that Nature herself does not always follow the rules of her own game.

A young chimpanzee having his teeth examined in the operating room of the up-to-the-minute animal hospital at the Bronx Zoo in New York City

Amazing Zoo Hospital

This strange collection of objects was found in the stomach of a dead cassowary. The ruler shows their size

JIMMY, the shoebill stork, was going under the anesthetic. A stone, thrown by a boy visitor to the Bronx Zoo in New York City, had smashed into the huge bill of this rare bird, cracking it open. Tiny spores of mold, similar to that seen on stale bread, were attacking the delicate exposed tissues. If these deadly growths spread to the lungs, Jimmy would die.

Sterilized surgical instruments gleamed in the glare of the lamp hanging over the white operating table. Slowly, skillfully, the doctor raised the broken, dangling ends of the injured bill. With cotton soaked in an antiseptic solution he swabbed the infected cavity. Carefully he bent back the smashed fragments and strapped them in place with sterile bandages and surgical tape. Attendants gently carried the valuable bird, still under the anesthetic, to a clean, warm pen in the hospital ward.

The operation was a success. Jimmy returned to his cage to strut before admiring throngs, but not until he had had more than a year of constant medical attention in the zoo hospital.

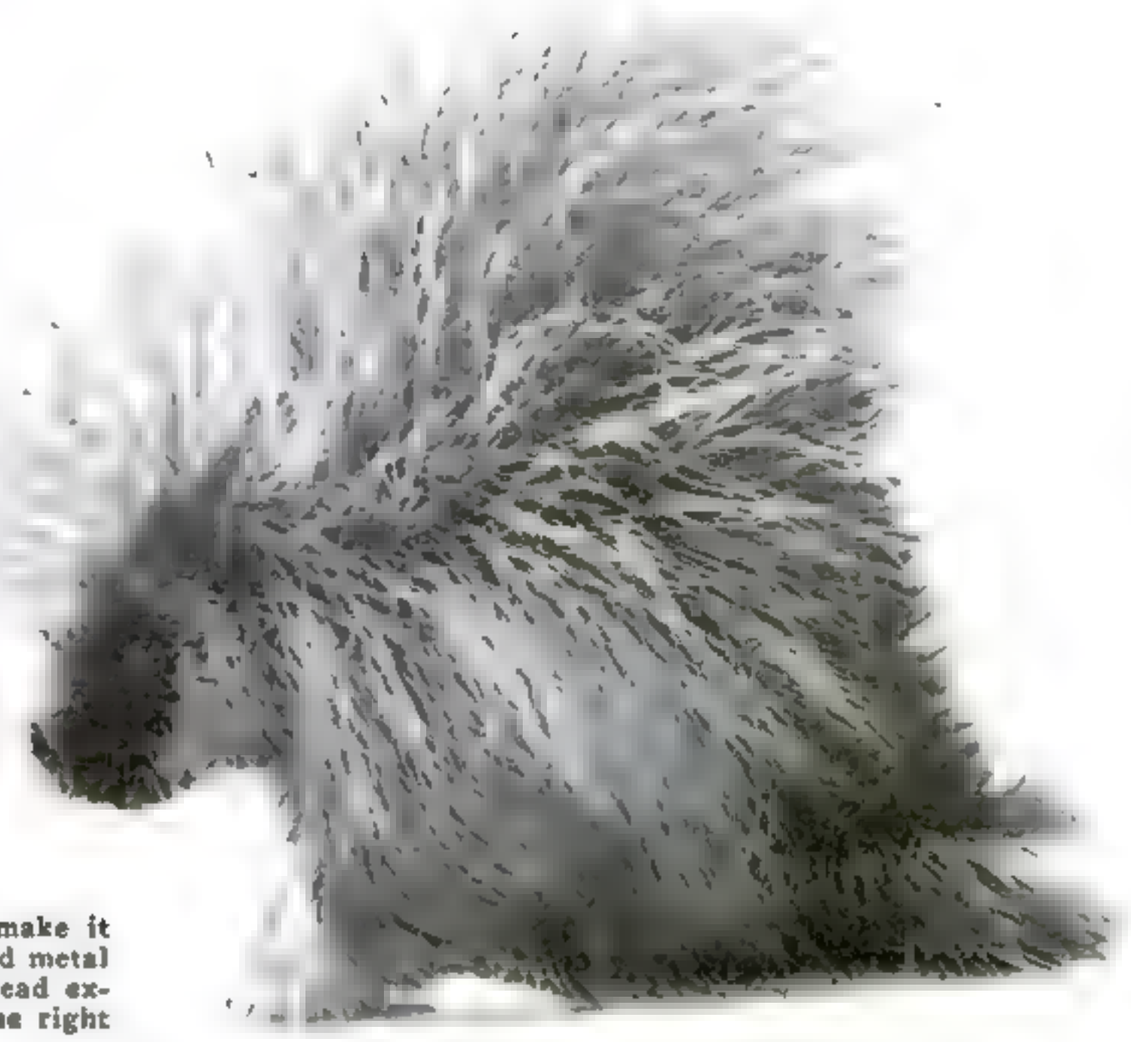
Delicate surgical operations like that are all in the day's work at the Bronx animal hospital. When I went to visit it, not long ago, I found the one-story, yellow brick building nestling in a little hollow in a quiet, secluded section of the park. Its flat roof is a maze of skylights, and of exhaust pipes for its modern electric ventilating system. Dr. Charles V. Noback, the veterinarian in charge, told me it was one of the best equipped zoo hospitals in the world. As we walked down one of its two spotlessly clean hallways, he pointed out the operating room, pathological laboratory, morgue, workroom, small-animal ward, pharmacy, and diet kitchen. Strong cages for tigers, gorillas, bears, and other large animals line the sunny south corridor of the hospital.

In one of these cages, Janet, the melancholy gorilla, was under observation because she had a sore leg—possibly a little touch of rheumatism. Janet first arrived at the zoo in 1928, then a sickly, bedraggled, and woebegone gorilla. Dangerously underweight, she had a hacking cough and showed traces of rickets, due probably to bad feeding on her long journey from Africa. One look at her doleful expression, and attendants dubbed her "Penserosa," meaning sad or melancholy. Hot lemonade, massage, cod-liver oil, rest, and a well-planned diet perked her up in short order, and soon she was out in one of the exhibition cages.

New arrivals at the zoo go directly to the hospital whether they appear sick or not. A quarantine period for newcomers is a vital step in preserving the good health of the entire animal community at the park, Dr. Noback explained. Held at the hospital for at least a week, new animals undergo blood tests and urine analyses. They are inspected for bugs and parasites, and rigidly examined for traces of infectious diseases that might spread to other animals. "The very presence of an animal on exhibition," Dr. Noback stated, "generally means that it is a sound and healthy representative of its kind."

Occasionally, however, hidden diseases elude even the watchful eyes of the hospital authorities. A rare bushmaster, a poisonous snake brought from Trinidad in the West Indies, died three months after it arrived at the park. An autopsy

By E. W. Murtfeldt



A CARRYING CASE FOR PORCUPINES

The "jelly roll," a strait-jacket devised by zoo doctors to make it possible to handle porcupine patients with comfort. The hinged metal case, fitted with a handle for convenience, leaves only the head exposed and covers the prickly quills seen in the picture at the right

Keeps Rare Animals Healthy

revealed that it was infested with several kinds of parasites. One of these, a Linguatula, had its four sharp claws locked in a death grip on the snake's heart muscle.

All animals that die at the zoo, whether from disease, accident, or old age, are taken to the hospital, where an autopsy is performed to determine the exact cause of death. This is done to help formulate better methods of treating animal diseases. Notes are made of the cases, and the carcasses are shipped to the American Museum of Natural History for further study.

Overfeeding causes a great deal of the sickness at the zoo. As a rule, however, the animals take care of themselves pretty well if they are left alone; it is the human visitors who cause most of the trouble. Despite warning signs and occasional arrests, visitors continue to feed the animals.

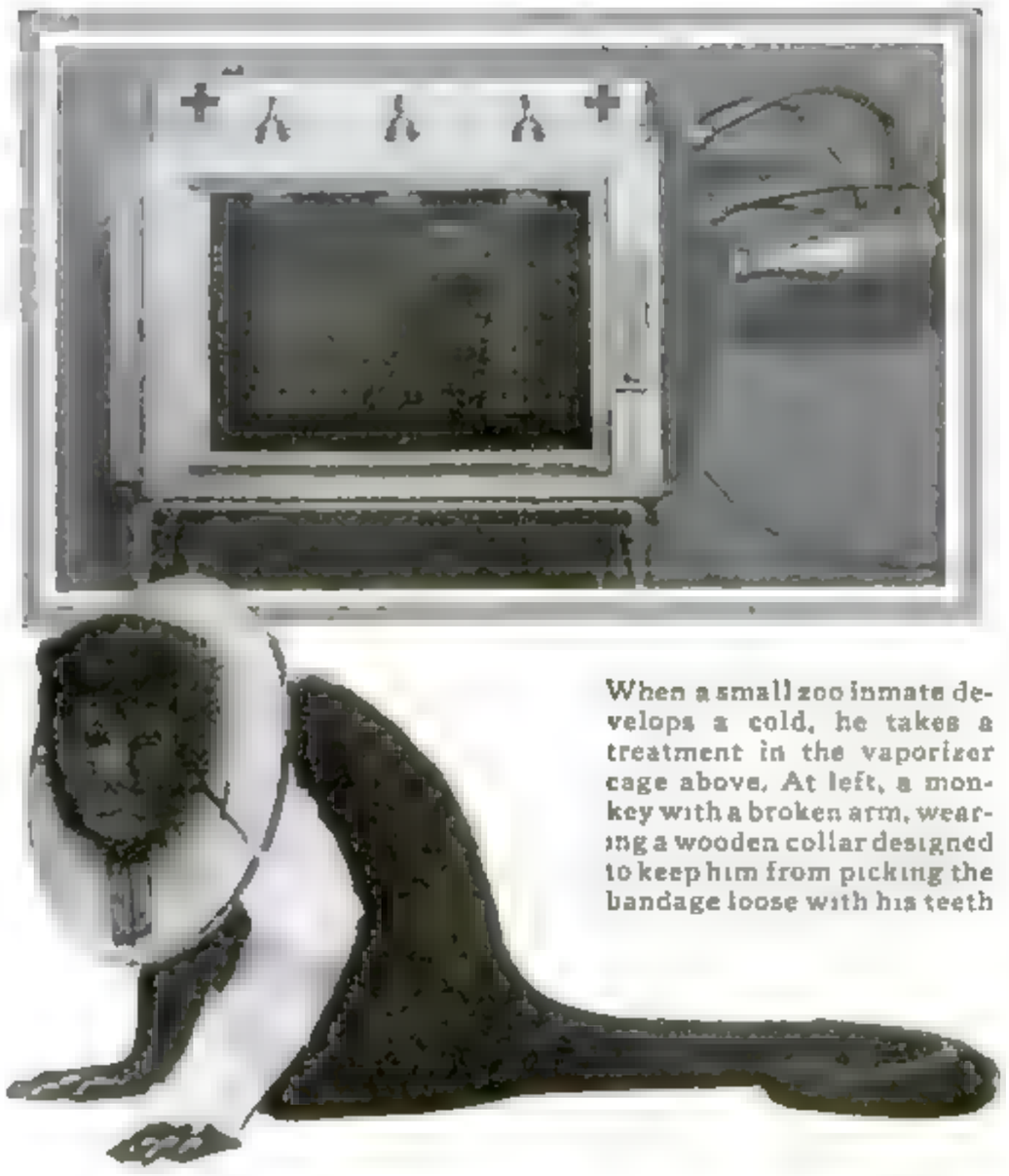
A peanut or a little pop corn cannot do any great damage, but when hundreds of people ply the animals with tidbits, the total amount sometimes reaches alarming proportions. Inmates of the zoo get stomach aches and indigestion, and must be removed to the hospital for treatment. Once, somebody tossed a peach to one of the American black bear cubs presented to the zoo by former Governor Alfred E. Smith. The animal promptly ate it, pit and all. The pit lodged in his digestive tract and caused him days of suffering.

Some visitors throw rubbish into the cages. Curiosity got the better of Janet Penserosa when somebody tossed her a lighted cigar. The gorilla grabbed it, played with it, and finally stuck it in her mouth —wrong end to. She had to be treated for a burned lip.

One of the park's playful sea lions died of gastritis because a visitor fed her a dozen large stones. Despite the best efforts of park officials, two or three sea lions die each year as the result of being fed some indigestible substance.

An ocelot at the park died after swallowing part of the covering of an umbrella. When Dr. Noback examined the stomach of a dead cassowary, a rare ostrichlike bird, he found an unbelievable array of objects: a rubber nipple, seven metal pop-bottle caps, a two-inch metal doll, a ball, a cork, a stone, a wooden spool, and, to top it all, the cover of a woman's vanity case that was over two inches in diameter.

The animal hospital has adequate equipment to care for all the ills and ailments that beset the zoo inhabitants. One odd device is an ingeniously constructed vaporizer for treating small animals with colds or snuffles. An armadillo, a monkey, or an anteater with a running nose is shoved into the inhalation chamber of the machine. This is a glass-covered metal cage heated by two rows of electric lights. At the side, an electric resistance coil generates eucalyptus vapor and a fan blows it through copper tubes into the inhalation cage. Animals used to kick up a big fuss when they were given vapor treatments by means of a mouth-and-nose mask. In this warm cage, they don't seem to object at all, and they are completely bathed in the medicinal fumes. So effective is the device that last year, a park policeman used to drop around for treatments. He could just get his head in the cage.



When a small zoo inmate develops a cold, he takes a treatment in the vaporizer cage above. At left, a monkey with a broken arm, wearing a wooden collar designed to keep him from picking the bandage loose with his teeth

Another clever device is the porcupine "jelly roll," a *(Continued on page 123)*

Has the Earth Turned

MOST people know that all our earth's seasonal changes are caused by the slant of the globe's axis in relation to the plane of its orbit around the sun. But few people have probably given very much thought to the forces which have caused this slant.

Astronomers have—but the answer still remains a big question mark. In their attempt to solve this riddle, however, one explanation, interesting and amazing, has been offered.

This theory, in effect, tells how the sun wrestles with every one of its planetary children and, to show its mastery, stands them on their heads, causing them to spin in the opposite direction to that in which they were started.

Better than the telling, however, the high-handed manner in which the sun upsets its offspring can be illustrated experimentally with a child's toy and a few other odds and ends available in any workshop.

Before we undertake the really fascinating gyroscope experiments, we must take the astronomer's privilege of leaping back a few thousand million years into the past to set the stage for this theoretical, cosmic wrestling bout which, according to some astronomers, is still going on between the sun and its progeny.

After the attraction of another star, passing too close to our sun, had raised out of its fiery ocean two enormously high tidal waves of fire, these spiral projections began to revolve slowly around the sun from which they had been torn (P. S. M., Aug., '34, p. 56).

As the rate of rotation increased, the speed became greater toward the center of the spiral planetary nebula, just as the center of the whirling water-vortex leaving a wash basin moves faster than the liquid near its edges.

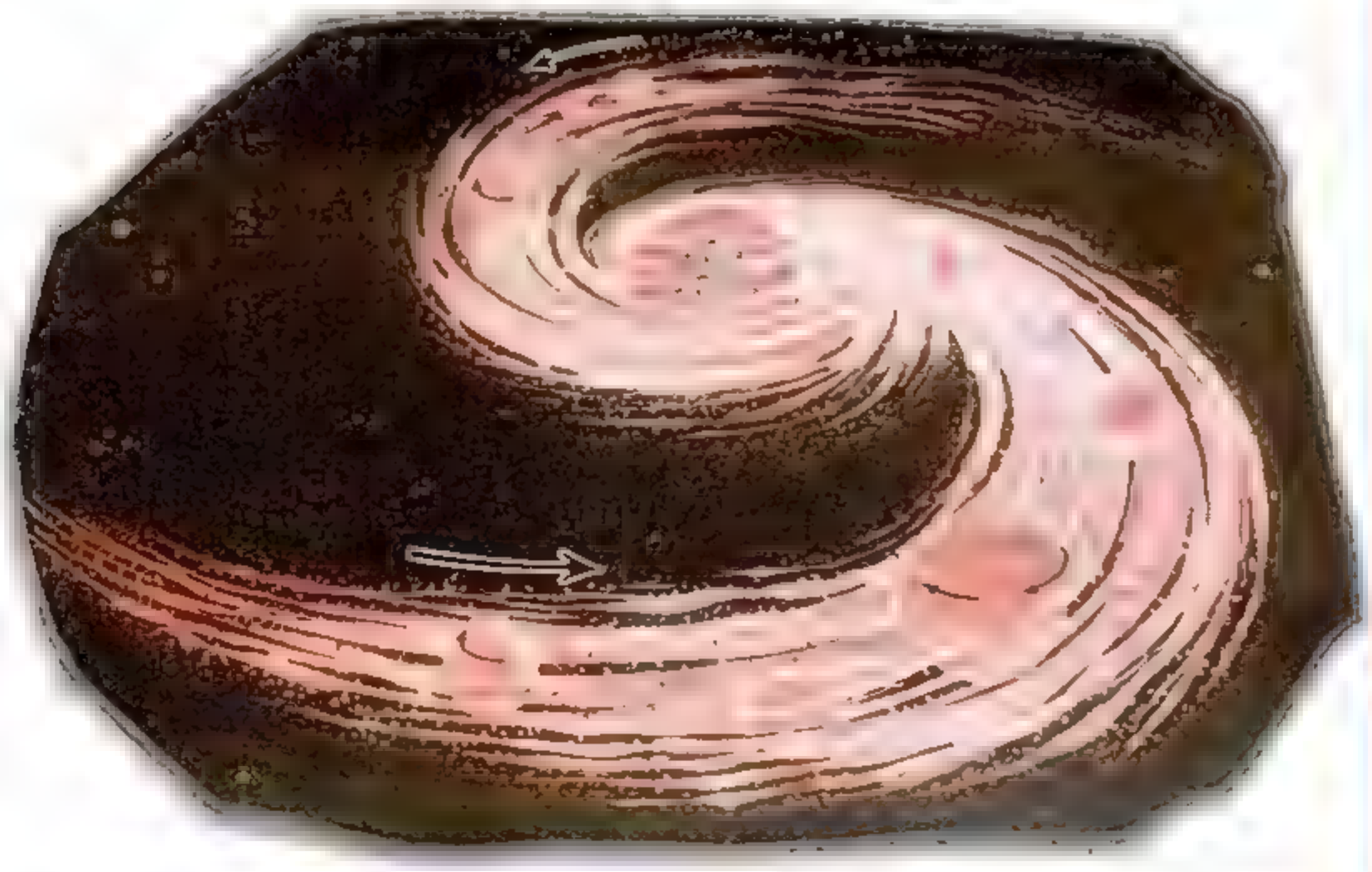
Along with the increase in speed of rotation, thickenings of the gaseous spiral arms began to appear here and there. These thickenings, destined to become planets, were, of course, enormously larger in volume than the worlds to be condensed later from them. But, even then, they were becoming spherical in shape.

When these globular forms appeared in the planetary nebula, the more rapidly revolving matter toward the nebula's center, whipping past on the sunward sides of the forming spheres, gradually set them into rotation, in the same way that a boy can whip a spinning top to make it go faster. But this rotation, oddly enough, began to take place in the *opposite* direction to that in which the nebula itself was turning! How did this happen? One of the illustrations shows clearly how the more swiftly moving matter nearer the sun hurried the sunward side of each ball of planet material until its rotation was started in a retrograde direction.

Then and there began the wrestling match be-

HOW EARTH MAY HAVE TILTED

With this simple apparatus you can illustrate the theory of somersaulting planets. When the top is spinning as shown in the topmost picture at the right, a pull on the string attached to the fork causes the gyroscope to turn over as illustrated in the successive pictures, until the wheel is rotating in the direction of the string's pull. A paper arrowhead is attached to one axis of the gyroscope to make its position apparent at a glance as it changes



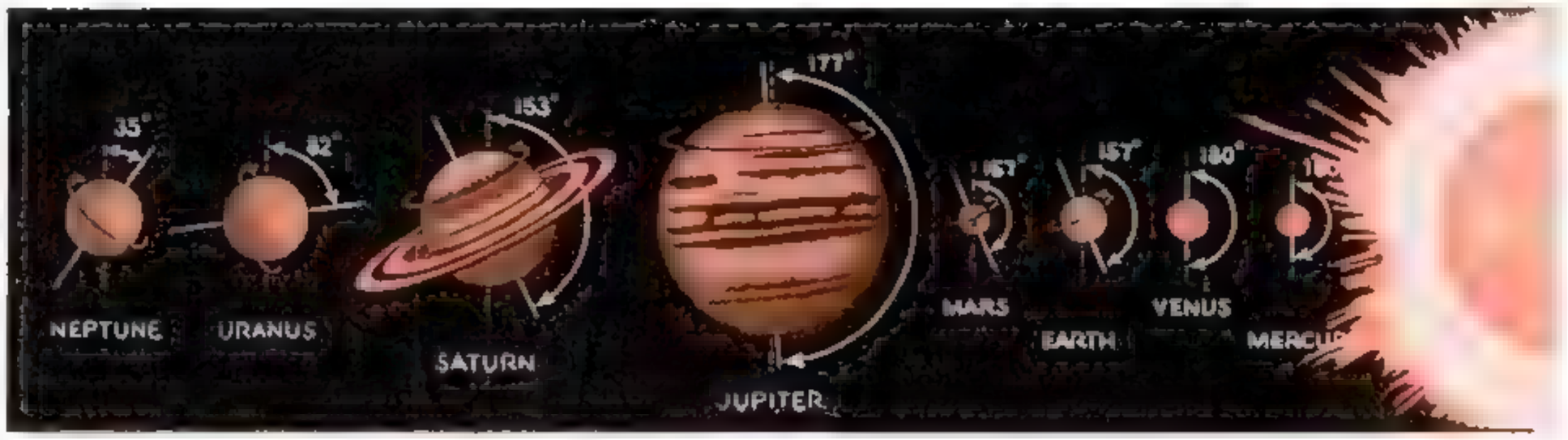
When the planets began to condense as gaseous spheres, according to this theory, the greater whirling speed of loose matter inside the nebula started them rotating in a backward or retrograde direction

Upside Down?

By GAYLORD JOHNSON

INCLINATIONS OF THE AXES OF PLANETS

This drawing gives the standing of the eight better-known planets in the race to turn over. Neptune has barely begun turning, while Uranus is halfway over; Jupiter lacks only three degrees of reaching an upside-down position



Fascinating Experiments Made with a Gyroscope Top Illustrate an Amazing Astronomical Theory

tween the sun and its children which we will presently get a thrill out of reproducing with a gyroscope top, slightly modified to imitate more closely the forces of the universe.

The gyroscope top, as I obtained it from the toy store, was simply a metal disk mounted on an axle with pointed ends, turning in bearings drilled in a surrounding ring. Every one knows how this spinning toy can be held horizontal by one end, made to walk a wire, and do other surprising tricks. But none of these interests us now. We want an entirely different trick from the top this time. To get it, we must mount the entire ring in a fork and the fork, in turn, must be free to turn horizontally upon a base.

One of the photographs shows how easily the top was modified for our purpose by soldering on nail bearings and drilling holes in the ends of a strip of brass which was then bent so as to make a forklike holder.

When the original gyroscope turned over and over freely on its nail bearings in the semicircular brass fork—and the fork also turned freely around and around on its nail attachment held in a hole in the wooden base—I was ready to try an experiment. But first, I attached a paper arrow to one end of the top's axis, to indicate its direction at a glance.

I began by tying a string to one side of the gyroscope's fork. The top was wound and spun in a clockwise direction.

With the wheel spinning rapidly, I pulled gently on the string attached to one side of the fork. Then came the surprise. I knew that I had fixed the fork so that it was free to turn easily on its base but even quite a strong pull on the fork by the string failed to budge it! Instead, the whole top turned slowly over toward me in its fork bearings. As I continued to pull, the arrow on the axis of the top pointed downward, just opposite to the direction it had at the beginning. Also, a finger touched to the spinning wheel showed me that the direction of its spin was now also reversed. When the experiment began, the wheel was spinning in a direction opposed to the pull on the string. After the top turned over, the wheel's spin agreed with the direction of the force pulling upon the fork. This will be made plain by a glance at the accompanying movie-strip illustration.

EFFECT OF TRAVEL AROUND THE SUN

With the fork fixed immovably in its base, the top is spun and the whole apparatus swung horizontally in an arc. The result, shown in the photographs at the left, demonstrates how a planet's momentum in its orbit assists the pull of the sun to overturn it

Our experiment has demonstrated a fundamental law of gyrostatics, which causes a freely moving gyroscope to turn over, around an axis at a right angle to the direction in which an external force is applied. This somersault comes to rest when the direction of spin no longer opposes the external force.

Now to see how this illustrates the wrestle between the sun and a planet. We have been told, according to this theory, that the slowly forming and condensing planet, in its embryonic days, is caused to rotate in a retrograde direction. Each newly formed planet, spinning rapidly, acts as a gyroscope—and the sun's pull accordingly tips it over until the direction of the planet's spin coincides with that of the entire solar system.

This amazing activity, common to toy gyroscopes and planets alike, was illustrated even more clearly by another experiment. *(Continued on page 108)*

New Devices FOR THE HOUSEHOLD

AN ICE PICK THAT CAN'T ROLL AWAY

The heavy metal ball set in the handle of this new stainless-steel ice pick is intended for pulverizing ice. It is put in the handle in such a way that the pick cannot roll away

SWINGING WASH BASIN. Mounted on a swinging bracket, the wash basin pictured above saves floor and wall space as well as metal pipe fittings. A rubber tube connects it with the tub faucet, and waste goes down the tub drain

When the tub is to be used, the wash basin is swung back into the corner where it is entirely out of the bather's way

MOISTURE-PROOF SHAKERS

Attractive new metal shakers for salt and pepper are so designed that, when filled, they seal themselves against moisture. The lower part is removed and the upper cylinder is filled two-thirds full. Salt or pepper comes out of the bottom when it is shaken with a vertical motion

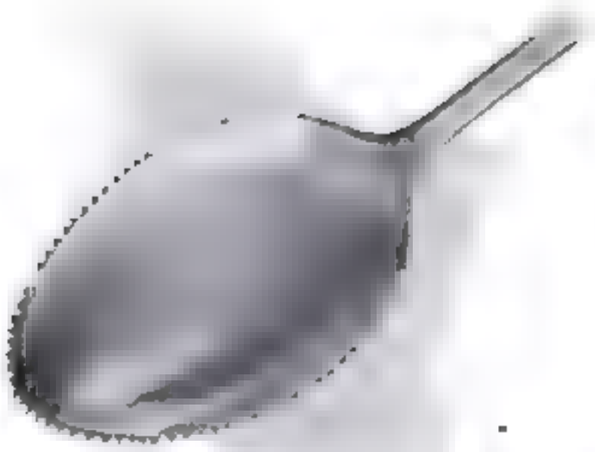
POTATO MASHER IS BUILT INTO POT

The latest thing in potato mashers is a pot with a special lid that has a revolving wire agitator inside it. A handle, set at an angle and far enough to the side to be away from the heat of the vegetables, turns the agitator to produce a light, creamy mash

SPRAY FOR FAUCET

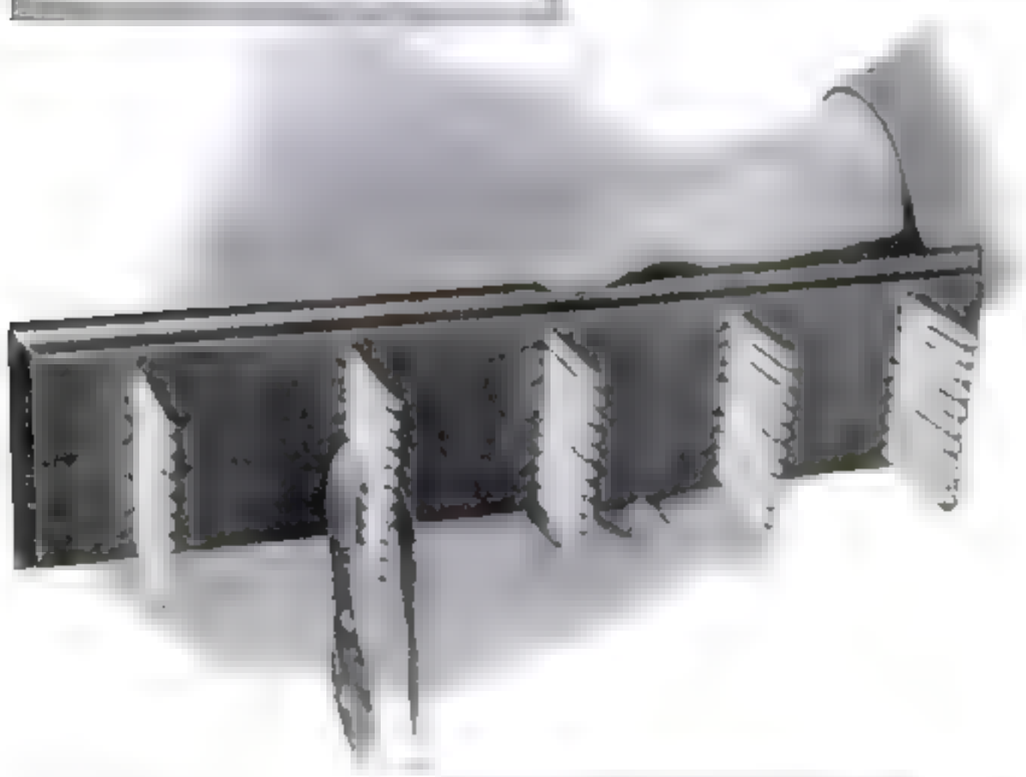
The faucet attachment shown at the right gives a fine needle spray under increased pressure, making it possible to wash and rinse dishes in one operation

FRYING-PAN GRILL. The chromium-plated grill pictured below can be placed in any frying pan for broiling bacon, chops, and other meats to a crisp, golden brown. It requires no attention while in use



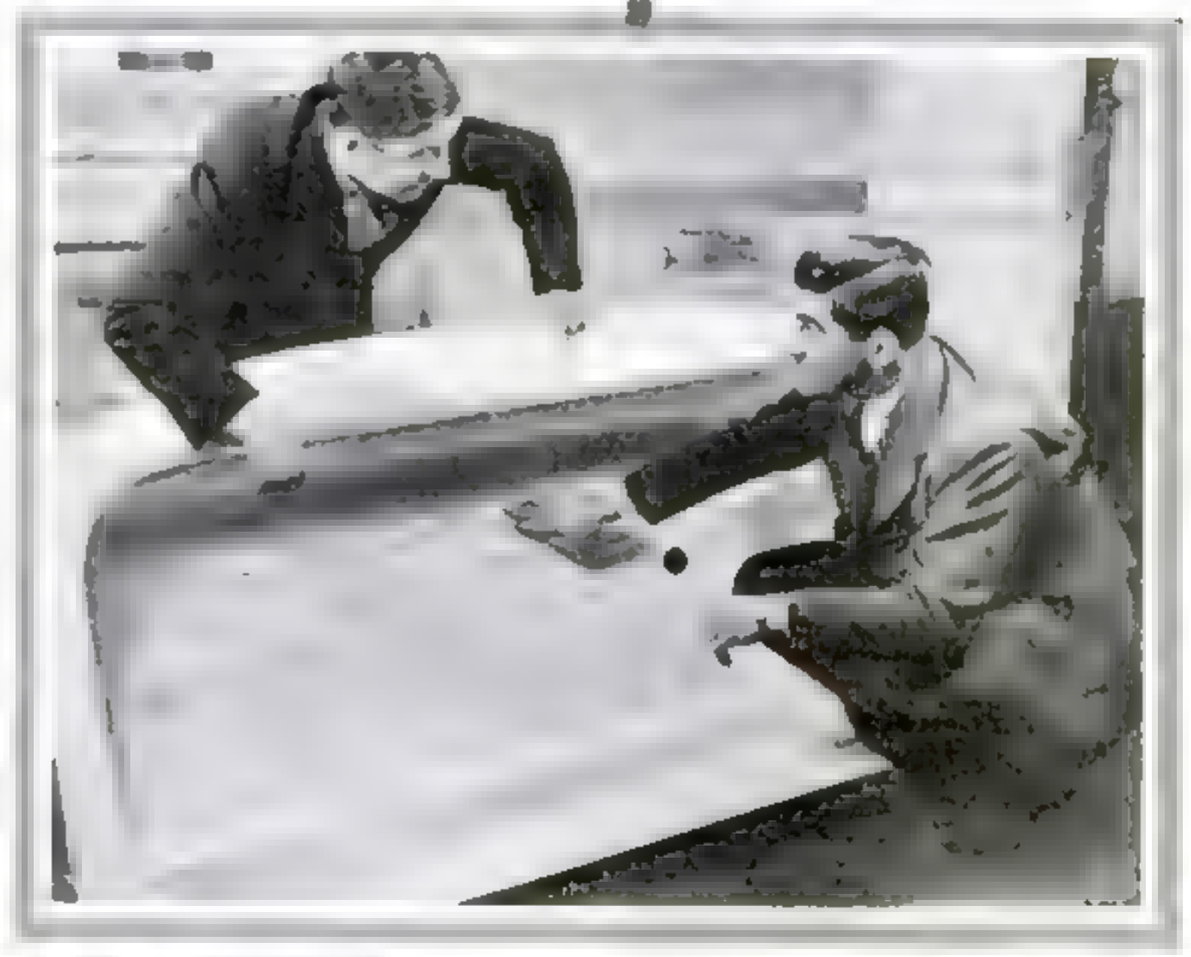
ELECTRIC SERVING TABLE. A single plug-in cord on this electrified table furnishes current for as many as three electrical appliances, which can be connected to a triple outlet located under the five-ply walnut-veneer top. When not in use, the table may be folded and employed as a fireplace screen, as at left

GRAPEFRUIT SCOOP. A saw-tooth edge, ground almost razor sharp, makes the spoon at the left a real help in preparing a grapefruit for the table. It cuts through the sections cleanly and leaves the rind intact for use as a shell if desired. Heavily chrome plated, the spoon is designed to harmonize with any cutlery pattern



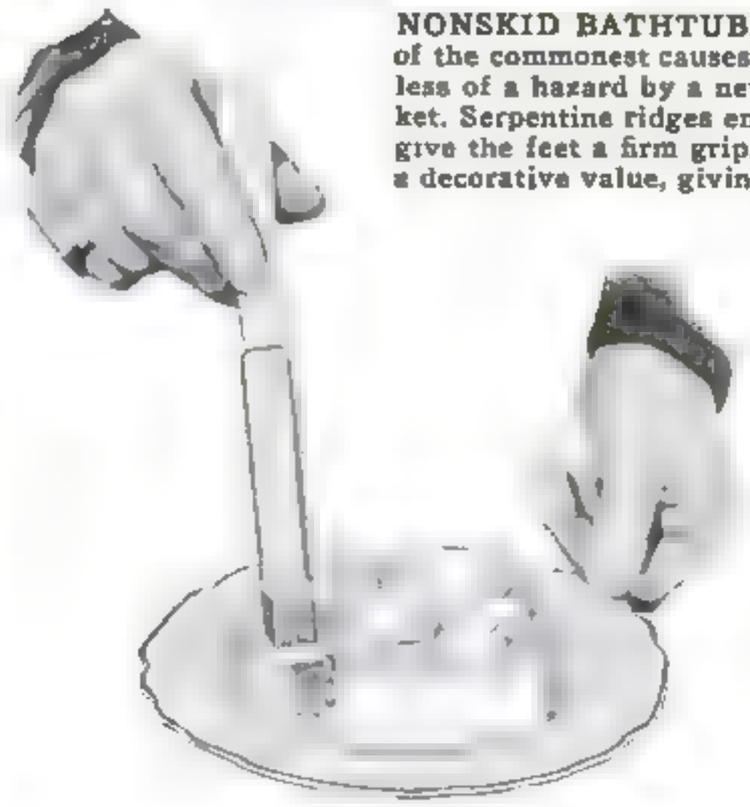
TIE RACK HOLDS FIFTY CRAVATS

Fifty roller supports, each capped with an aluminum ball tip, provide individual places for the same number of neckties on the compact rack illustrated above. A smaller size, accommodating thirty ties, is also available



SHADE IMITATES VENETIAN BLIND

The effect of a costly Venetian blind is produced by this washable window shade. It has the likeness of the blind printed on it in such a way that light streams through the "slats" realistically



NONSKID BATHTUB. Slipping in the bathtub, one of the commonest causes of injury in the home, is made less of a hazard by a new tub just placed on the market. Serpentine ridges embossed on the bottom surface give the feet a firm grip. At the same time, they have a decorative value, giving an appropriate marine touch

MAKES CHEESE CUBES

Neat cubes of cheese, for serving in many forms, are produced by the novel cheese knife illustrated. As the tool is pushed through the cheese, the cubes slide out of it one by one. Fluted edges give the titbits an unusually appetizing look

Sulphur Dioxide *Provides*

A simple set-up for generating sulphur dioxide. The interaction between concentrated sulphuric acid and copper, aided by heat, liberates the gas. It is passed through a drying bottle filled with sulphuric acid, and into a U tube packed in ice and salt to change it to a liquid

IF YOU have ever burned any sulphur in your home laboratory, the pungent smell of the vapor probably lingers in your memory. This is what most people mean when they speak of the odor of sulphur. The fact is, however, that sulphur has almost no odor of its own. What actually causes the acrid scent is the product of combustion, sulphur dioxide gas.

Sulphur dioxide is easy to generate in quantity, and lends itself to a number of striking and interesting experiments. Among other things, you can show how readily it may be transformed from a gas into a liquid, and vice versa, by changes in temperature or pressure—a property that adapts it to one of its important uses, as a cooling medium in household refrigerators of the mechanical type.

The interaction between strong (concentrated or undiluted) sulphuric acid and metallic copper provides a convenient way of making sulphur dioxide. This is carried out in a flask fitted with a two-hole stopper. Insert a thistle funnel or a separatory funnel, for admitting the acid, in one of the holes; and an L-shaped outlet tube in the other.

When scraps of copper have been placed in the flask, and acid has been added through the funnel, heat from your laboratory burner will liberate the sulphur dioxide. The gas may contain water vapor, however, which should be removed. It is therefore led to a drying bottle filled with strong sulphuric acid, through which it bubbles, losing any moisture it contains. The acid in the drying bottle may later be used in other experiments, for which it will be unimpaired by any sulphur dioxide that it contains as an impurity.

After passing through the drying bottle, the sulphur dioxide gas from your generator is led through a U tube packed in a mixture of ice and salt. A combination producing a temperature of ten degrees below zero, centigrade, will chill the sulphur dioxide sufficiently to change it from a gas to a liquid, in which form it may be collected. An excess of unliquefied sulphur dioxide gas, which may escape from the exit end of the U tube, can be kept from contaminating the air in the house by leading it through a length of rubber tubing to a partially opened window.

After the generator has been in operation for a little while, and you have collected several cubic centimeters of the liquefied gas, you can remove the U tube temporarily from its packing and experiment with the properties of the fluid.

Liquid sulphur dioxide readily turns back into a gas, you will find, as its temperature rises. Drops allowed to fall from the end of the U tube fume strongly in the air and vaporize. The liquid is rapidly gasified when it is poured into water, producing a hissing noise and a marked cooling effect. A small quantity of water can be frozen in this way. Absorption of heat when a liquid changes into a vapor, as demonstrated with sulphur dioxide in this experiment, is the principle on which mechanical refrigeration is based.

After the preceding experiment is performed, some of the sulphur dioxide will be found to have dissolved in the water, producing sulphurous acid. The presence of the acid may be shown by dipping blue litmus paper into the water; the test paper will turn red.

Bits of sulphur, dropped into liquefied sulphur dioxide, will dissolve.

Sulphur dioxide also may be changed from a gas to a liquid by subjecting it to pressure. A striking experiment to demonstrate this can be performed by fitting your U tube with an improvised piston, made from a rubber stopper of suitable size. The stopper should be lubricated with vaseline and pierced with a bent rod that serves as a handle. If the end of the rod is threaded and nuts and washers are placed above and below the stopper, the latter is sure to remain firmly in place.

With the generating apparatus in operation as before, raise the U tube partially from the freezing mixture, allowing the temperature within the tube to rise a little. The entire contents will then consist of sulphur dioxide gas. Now disconnect the U tube from the drying bottle and remove the flame from beneath the generating flask. Close one end of the U tube with a rubber stopper, and plunge your homemade piston down the other branch of the tube.

At the first down stroke of the piston, you will see the gas liquefy and collect in drops at the bottom of the tube. With a temperature of zero degrees centigrade, the freezing point of water, this will happen when the piston is exerting only half again as much pressure as that of the atmosphere, or about twenty-three pounds to the square inch.

Higher pressures than this could be obtained with your improvised piston, and would cause

Pressure applied by means of this improvised piston liquefies sulphur dioxide gas confined in the U tube

Fascinating Home Experiments

STRANGE PROPERTIES OF THIS GAS EXPLAIN PRINCIPLES OF MECHANICAL REFRIGERATION

By Raymond B. Wailes

the gas to liquefy at pressures well above freezing. In fact, with sufficient pressure it is possible to liquefy sulphur dioxide at room temperature. If you attempted to do this with the simple apparatus described, however, the cork would probably be expelled from the U tube, or the tube would burst. The use of an ice-salt mixture to reduce the amount of pressure required is therefore desirable in this experiment.

IF YOU have placed enough material in the generating flask to continue producing sulphur dioxide, you can now try some experiments with the gas itself as it comes from the drying bottle.

Since the gas is heavier than air, it is easily collected as it pours downward from the outlet tube. Small samples for immediate use may be obtained by holding a test tube beneath the outlet, and closing it with the thumb after it has had time to fill with the gas. Larger samples may be collected in wide-mouthed bottles; a convenient aid for this purpose is a short length of glass or rubber tubing, attached to the outlet tube, that reaches to the bottom of the bottle so that the incoming sulphur dioxide will displace the lighter air above it. In half a minute or so, the bottle will be full of the gas. A sheet of cardboard or glass should then be laid across the mouth of the bottle so that the contents will not escape by diffusion.

A lighted candle lowered into a bottle containing the gas is extinguished

Fill a test tube with sulphur dioxide gas and place it mouth downward in a shallow basin of water. When the mouth is uncovered, the liquid rapidly mounts within the tube, showing the high solubility of the gas in water. As fast as the gas dissolves, the water, responding to external atmospheric pressure, climbs upward in the tube to take its place.

Many flowers are bleached by sulphur dioxide gas, and pink or red roses show this effect particularly well. They must be dampened with water before being exposed to the gas, however, or the experiment will not be successful.

Sulphur dioxide reacts with heavily oxygenated substances like potassium permanganate and potassium dichromate, reducing them to other compounds. Pour a solution of potassium permanganate, which has a purple color, into a bottle of sulphur dioxide gas, and the solution becomes colorless. Potassium dichromate solution, which is orange in color, becomes green when it is subjected to the same treatment. Another way to observe the color changes is to dip white paper into either of the solutions, and lower the saturated paper into a bottle of the sulphur dioxide gas.

Although sulphur dioxide contains two parts of oxygen to one of sulphur, the gas parts with its oxygen so reluctantly that many substances will not burn in it. A lighted match, or a burning candle affixed to a wire handle, will go out when lowered into a bottle of sulphur dioxide gas, because of the lack of free oxygen to support combustion.

Lower a burning strip of magnesium ribbon into another bottle of sulphur dioxide gas, however, and you will observe that it continues to burn. In this case the hot metal actually tears the gas apart, breaking it down into its component parts and thus obtaining oxygen for combustion. Other metals—tin, antimony, lead, and iron—will also burn in the gas, although the reaction is less intense. To compare their behavior, specimens of the metals may be placed in turn in a deflagrating spoon (a small shallow pan with a stiff wire handle), heated as hot as possible over a Bunsen burner, and lowered into a bottleful of the gas. Hot brown lead peroxide glows brightly in sulphur dioxide gas, and is transformed into white lead sulphate.

The fact that sulphur dioxide is reluctant to let go of its oxygen and eager to take oxygen away from other substances makes it useful as a commercial chemical.

When a burning strip of magnesium ribbon is placed in sulphur dioxide, it breaks down the gas to obtain oxygen for combustion, and burns with a bright flame

Large quanti- (Continued on page 125)

Handy Water Dispenser Made with Cheap Atomizer

A HANDY dispenser for small quantities of water obviates the inconvenience of making up a few drops of a solution, or filling a graduate exactly to a given level, with water from a running tap. The device illustrated may be assembled from a flask or bottle, a two-hole rubber stopper, a few pieces of glass and rubber tubing, and the rubber bulb of a ten-cent atomizer. When the bulb is pressed, air is forced into the bottle, expelling a little of the water in the vessel from a glass nozzle. The air-inlet tube ends just below the cork, while the other tube dips into the water. The nozzle is cut from a glass tube that has been drawn out after heating in a flame, to give the tip a fine bore. If a bottle is used instead of a flask, it is desirable to select a squat one, as a tall bottle is more likely to be knocked over frequently. In the illustration shown here, the dispenser is being used to add a minute amount of water to a solution in a test tube—an operation that must be carried out many times in the course of experimenting in the home laboratory.

Simple Scientific Tests

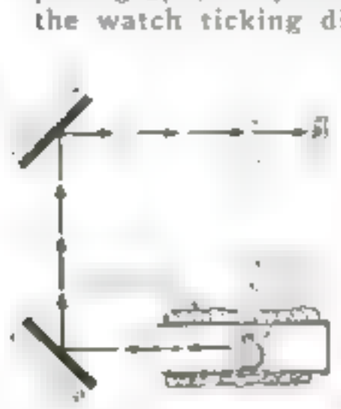
FOR THE AMATEUR EXPERIMENTER

VACUUM CAUSES AN UNEXPECTED EFFECT

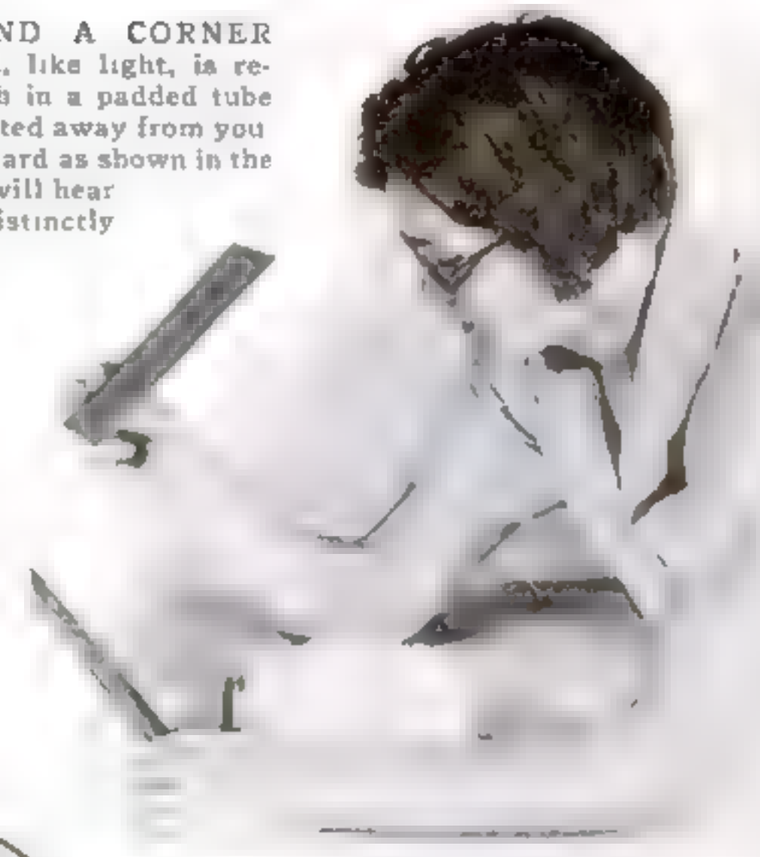
You would think that the stream of air blown between the table-tennis balls would force them apart. Instead, it creates a partial vacuum that draws them together

HEARING AROUND A CORNER

To prove that sound, like light, is reflected, place a watch in a padded tube with the opening pointed away from you Hold pieces of cardboard as shown in the photograph, and you will hear the watch ticking distinctly



Drawing shows how pieces of cardboard reflect sound waves



TESTING SURFACE TENSION

In the experiment pictured below, raising the wire stretches the rubber band until it pulls the tin disk from the liquid. The force required, indicated on the ruler, will show the relative surface tensions of the liquids tested

A BUZZER MAKES A SIMPLE SHOCKING MACHINE

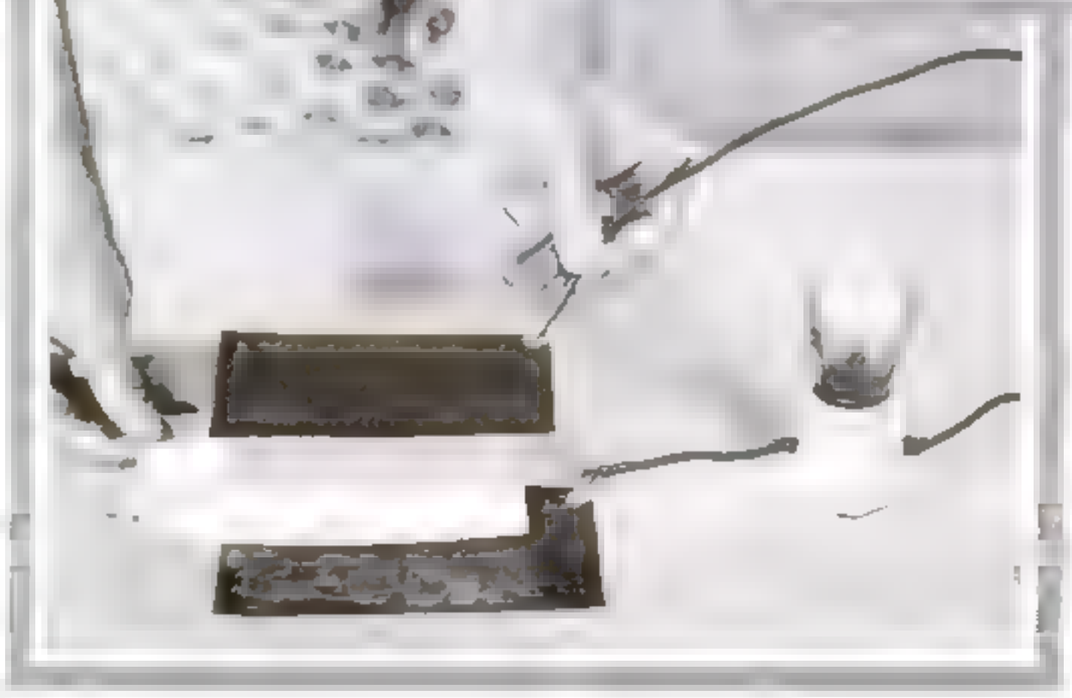
Connect a tin-foil grip to one of the binding posts of a buzzer operated on a step-down transformer, and another to the contact arm. By pressing one of the grips firmly in each hand, you will get a distinct shock. The device is quite harmless

MAGNET REPELS IRON IN SPINNING TOP

Make a top from a can lid and a pointed stick. While it is spinning, hold a permanent magnet above the disk as shown above. The top will lean to one side, indicating that the metal is repelled. This surprising effect is produced by eddy currents that the magnet induces in the rapidly rotating metal disk of the top

SOAP PROVIDES MOTIVE POWER

A flat spiral of wire floats readily in a pan of water. If you touch the water in the center of the spiral with the corner of a bar of soap, the wire will whirl around. The motion is caused by surface-tension effects



INSULATORS TESTED WITH NEON LAMP

A 110-volt neon lamp, wired to metal plates as at left, glows more or less brightly depending on the insulating material that is placed between the plates Cloth, paper, mica, celluloid, and other substances cause wide variations in brightness The material under test is merely sandwiched between the two metallic plates

NEW HELPS FOR Radio Builders

New radio tool in use for checking tuning inductances in a receiver. Inset shows end of wand containing a special core. The other end is brass

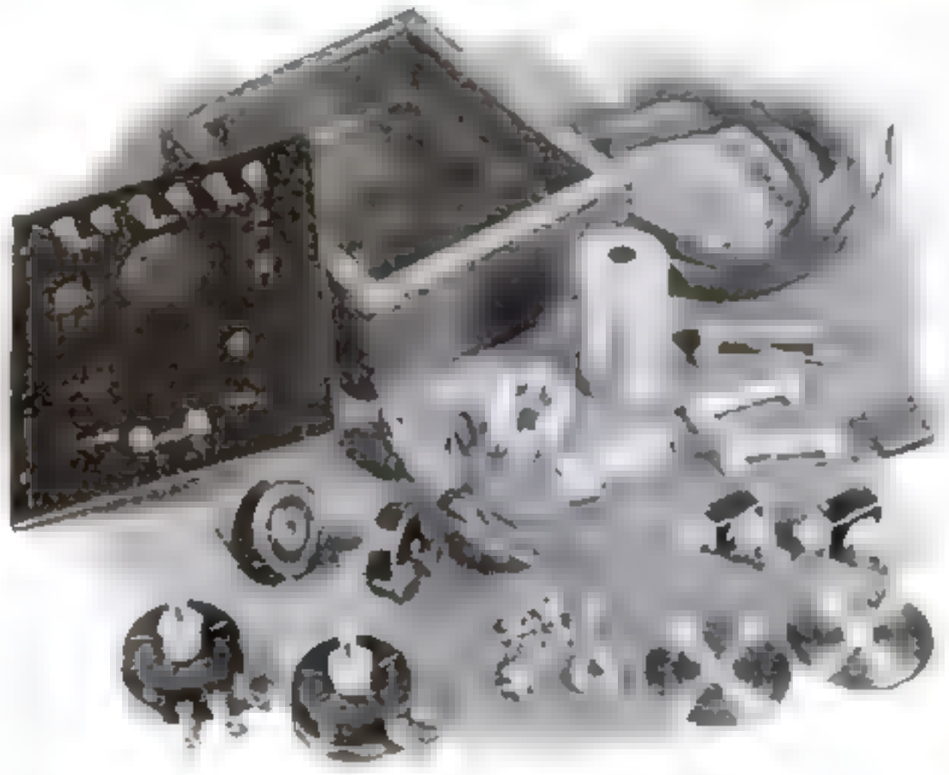
RESEMBLING a magic wand, the newest tool for amateur experimenters and set builders makes it an easy matter to check the tuning inductances in any receiver. Placed in the magnetic field of the inductance, it determines instantly whether the inductance is too high, too low, or just right. The wand, a flexible piece of rubber, is tipped at one end with a brass cap while the other end contains a special metallic core. If inserting the brass end in the inductance increases the volume of the receiver, the inductance is high. Low inductance is indicated if the volume increases when the cored end is inserted. If the signal is decreased with the insertion of either end, the circuit is properly aligned. Being flexible, it can be used in cramped quarters.

Short-Wave Tuning Dial Gives World-Wide Time

CALLED a "chronomatic dial," the latest short-wave tuning aid not only provides two large scales for tuning, but a supplementary world-wide time-conversion scale. Provided with two controls, the right-hand knob turns a slender pointer over the tuning scales while the left-hand control adjusts the time scale to give the converted time in all of the important sections of the globe. For instance, as set, the time-conversion scale shows that when it it is three o'clock in California, it is six o'clock in Montreal, New York, and other cities on Eastern Standard Time, eleven o'clock in London, and twelve o'clock in Berlin. To determine the converted time at other hours, the time knob is merely turned until the desired time numerals appear for the desired locations. To avoid confusion, black figures indicate A.M., red figures P.M.

Kit Makes Accurate Vacuum-Tube Voltmeter

WITH a complete kit of parts now available, the radio experimenter can provide himself with an accurate vacuum-tube voltmeter. Making use of a midget acorn tube (see P.S.M., Jan. '35, p. 58), the outfit is said to insure maximum accuracy by allowing the tube to be placed directly at the point of the measurement, thus eliminating the necessity of long leads. The kit includes a panel completely drilled, with the various leads and controls labeled. When assembled in the crackle-finished cabinet, the outfit has the smart appearance of a professional factory job.

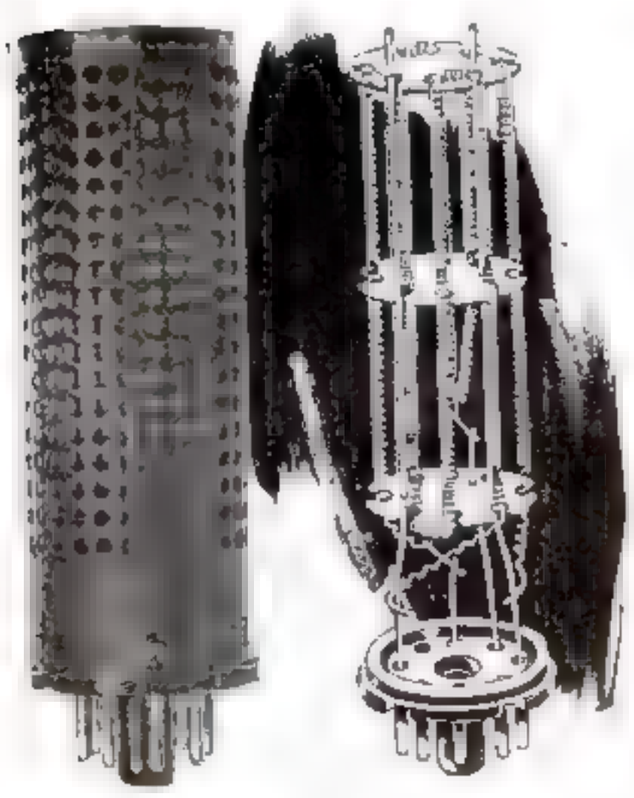


Complete materials for assembling a vacuum-tube voltmeter. The kit includes a cabinet and a panel drilled and lettered

Decorative Fuse Holder Is Mounted on Panel

Cartridge-type fuse being inserted in a decorative holder that mounts on the panel

FUSES can be mounted directly on the panels of meters, receivers, and similar equipment with the new decorative fuse holder recently placed on the market. Easily mounted in a single hole drilled in the panel, the holder takes a special miniature cartridge-type fuse available in a variety of sizes ranging from five to 2,000 milliamperes. A screw cap of attractive marblelike, plastic material holds the fuse in place and provides an easy means of making replacements. Two soldering lugs at the rear of the holder simplify the matter of connections and a fiber bushing at the rear of the holder insulates it from the panel.



This combination resistance unit is housed in a metal shell that plugs in a socket

Plug-In Resistance Elements

COMBINATION resistance elements for use in series with receiver tubes and pilot lamps operated on 110-volt house-lighting circuits are now available in convenient plug-in form. Housed in perforated metal shells and fitted with standard eight-prong bases like the new metal tubes, they can be plugged into regular octal sockets mounted on the face of the receiver chassis. The units are available in different resistance values, providing voltage drops for from one to seventeen 6.3-volt, .3-ampere tubes on 117-volt lines. Units can also be provided with sections taking care of 6-8 volt 0.25 ampere pilot lights. Other combinations and ratings can be obtained which will meet special requirements set up under certain conditions.

Three-Tube Amplifier Has

By STANLEY JOHNSON

THIS simplified, inexpensive amplifier will make any headphone receiver a loudspeaker set. If you are a short-wave experimenter, it will make it possible for your friends to hear your one- or two-tube outfit with real loudspeaker volume. If you are an amateur operator, tired of clamping phones to your ears to hear a signal, you can lay the "cans" on the table, connect the amplifier to your receiver, and hear the same signal come pounding in on the loudspeaker.

The unit, which is complete with built-in loudspeaker, uses a type '76 tube resistance coupled to a type 12A7 combination rectifier and power-pentode tube, giving the equivalent of three-tube operation with only two tubes. Since the unit has its own power supply, it may be shifted from one set to another in a few seconds. No power transformers are necessary, and the amplifier may be operated from either alternating- or direct-current, 110-volt lines.

Connected in series, the filaments of the two tubes receive their voltage through the dropping resistor (R_7), which is a part of the power cord. Plate current is provided by a built-in power supply consisting of the rectifier portion of the type 12A7 tube, a dual filter condenser (C_5 and C_7), and a low resistance filter choke (Ch). The pentode portion of the 12A7 drives the inexpensive five-inch magnetic speaker while a variable resistor (R_1), connected in the input circuit of the '76 tube, allows the output to be varied from a faint whisper to speaker-rattling volume.

All of the parts, except the speaker and choke, are mounted under a 4½ by 7-inch metal chassis. This mounting can be made from a standard 7 by 9-inch metal chassis simply by cutting it in two with a hack saw. A pipe reamer can be used to "drill" the large holes for mounting the five-prong and seven-prong sockets.

A 7½ by 7½-inch wood-composition panel, bolted to the front of the chassis, not only provides a means for mounting the loudspeaker and volume control but also serves as an effective baffle. The cone of the loudspeaker can be protected by a piece of heavy silk glued to the back of the panel to form a decorative grille. If desired an inexpensive escutcheon can be added.

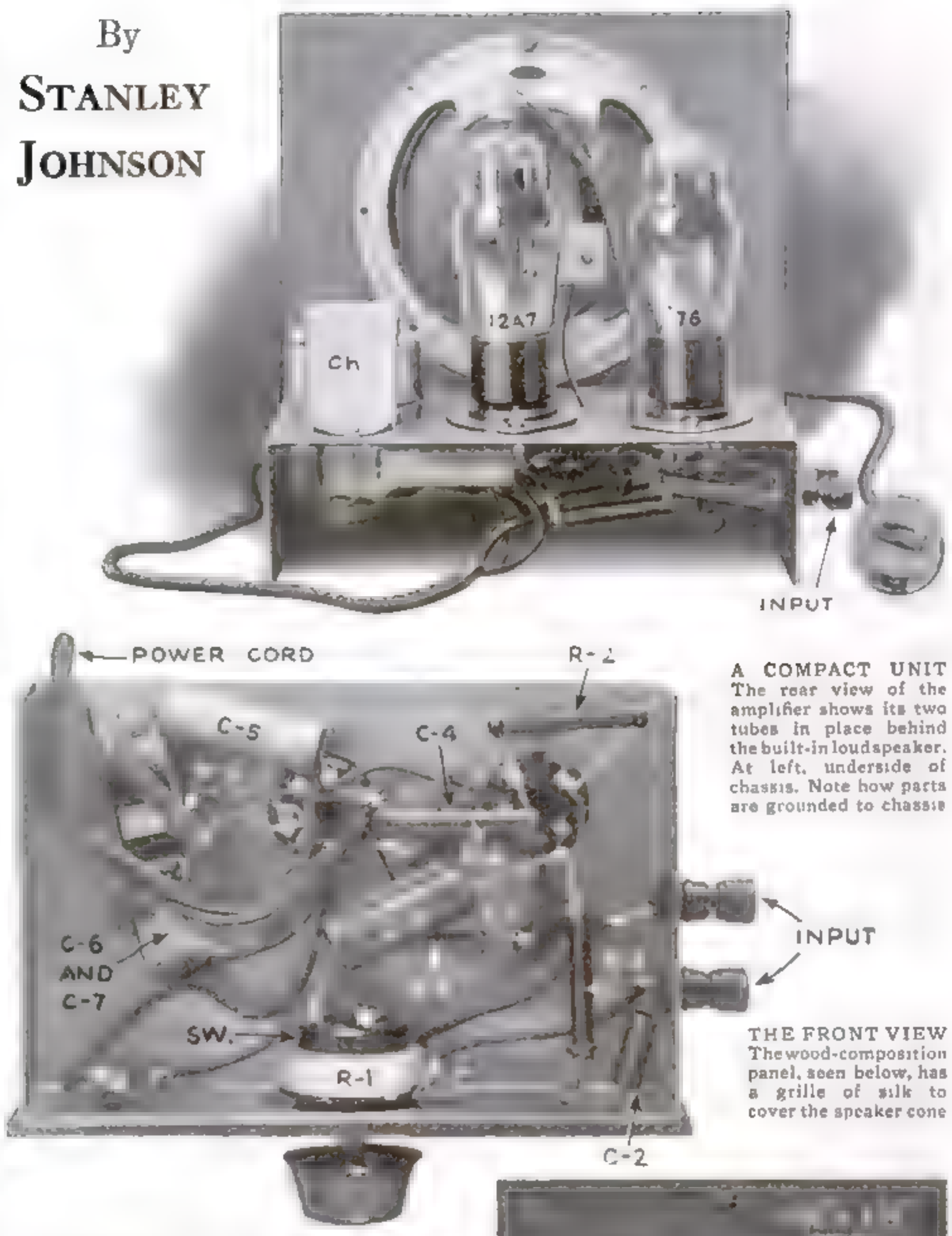
Since this is an audio-frequency circuit, the length of the various leads is relatively unimportant and the parts can be mounted in any manner which makes wiring easy. In most cases, the tinned leads of the resistors and condensers are long enough to provide the necessary connections. The few additional connections can be made with flexible hook-up wire.

By allowing the chassis to provide an electrical "ground," the wiring is simplified considerably. However, care must be exercised to see that parts not to be grounded, such as the input binding posts, are mounted so that they are not accidentally shorted against the chassis. In the diagram, all ground symbols refer to chassis connections, no actual ground connection being used.

Since the power cord contains the built-in dropping resistor (R_7) necessary to supply the filament voltage, it must be connected properly or the tubes will be burned out. The three leads (A, B, and C) generally are of different colors. However, since the color codes used by the different manufacturers vary, it is advisable to check the cord to see which of the three leads is the resistor.

A radio service man who has an ohmmeter can determine this for you in a few minutes, but you can make the check yourself simply by using a pair of headphones and a dry cell for a "continuity" test. Connect one tip of the headphone cord to one of the terminals of a dry cell; to the other terminal of the cell, fasten a length of flexible wire. When the end of the flexible wire is touched to the second headphone tip, a loud click will be heard in the headphones. Thus, by connecting the flexible wire to one side of any circuit and touching the headphone tip to the other side, it is possible to tell if the circuit is passing current.

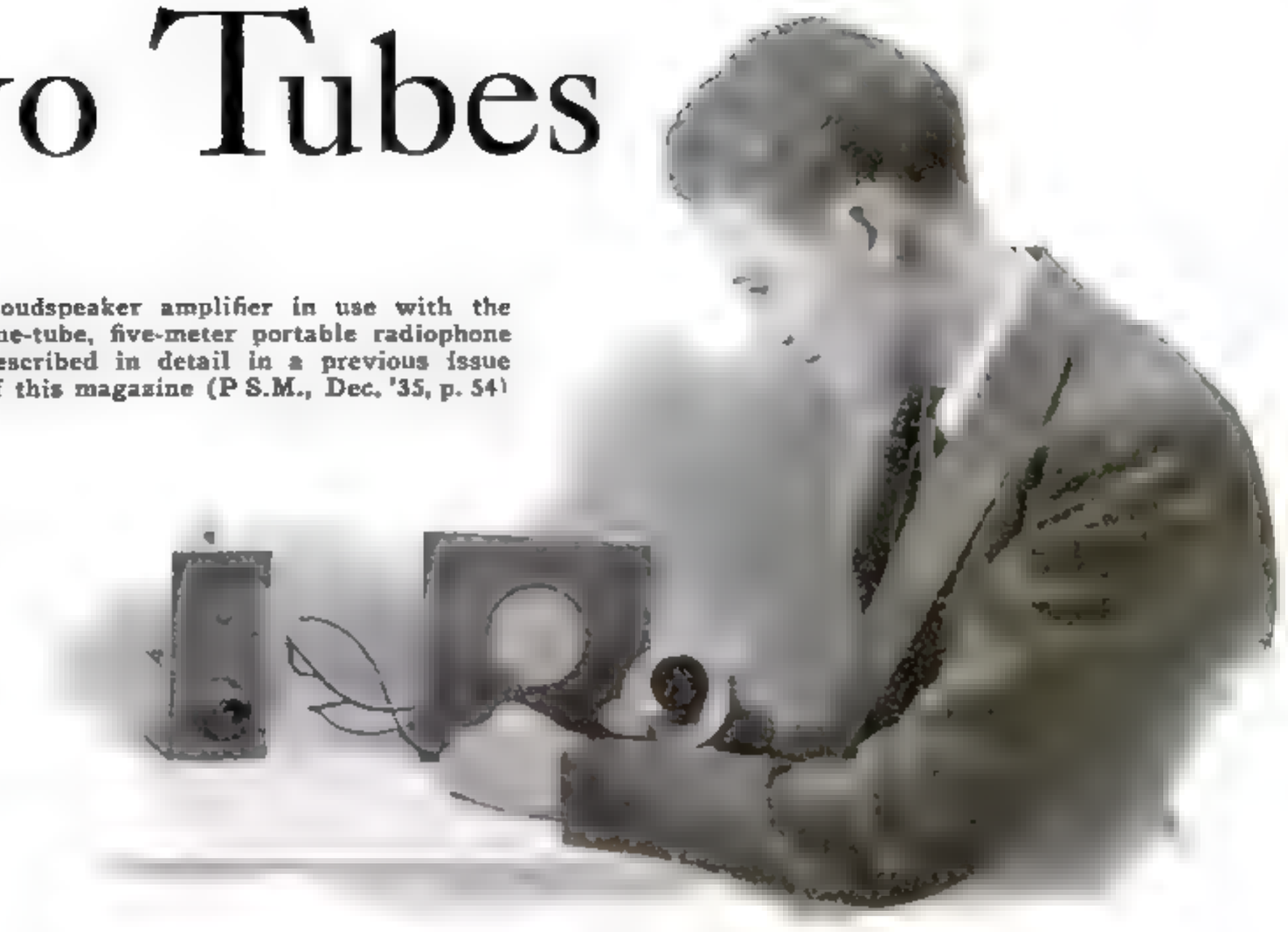
Before using this circuit to test the power cord, study the wiring diagram carefully. You will notice that two of the



A COMPACT UNIT
The rear view of the amplifier shows its two tubes in place behind the built-in loudspeaker. At left, underside of chassis. Note how parts are grounded to chassis

THE FRONT VIEW
The wood-composition panel, seen below, has a grille of silk to cover the speaker cone

Only Two Tubes



Loudspeaker amplifier in use with the one-tube, five-meter portable radiophone described in detail in a previous issue of this magazine (P S.M., Dec. '35, p. 54)

power-cord leads are connected together; that is, the resistor is connected to one side of the power line. The first step is to determine which two of the three leads are connected together. This can be done by connecting the flexible wire to one of the power-cord leads and then touching the headphone tip to the remaining leads, one at a time. If, on touching a lead, no click is heard, that lead can be eliminated. If a click is heard, the lead is either the resistor or the lead from the power line to which the resistor is connected.

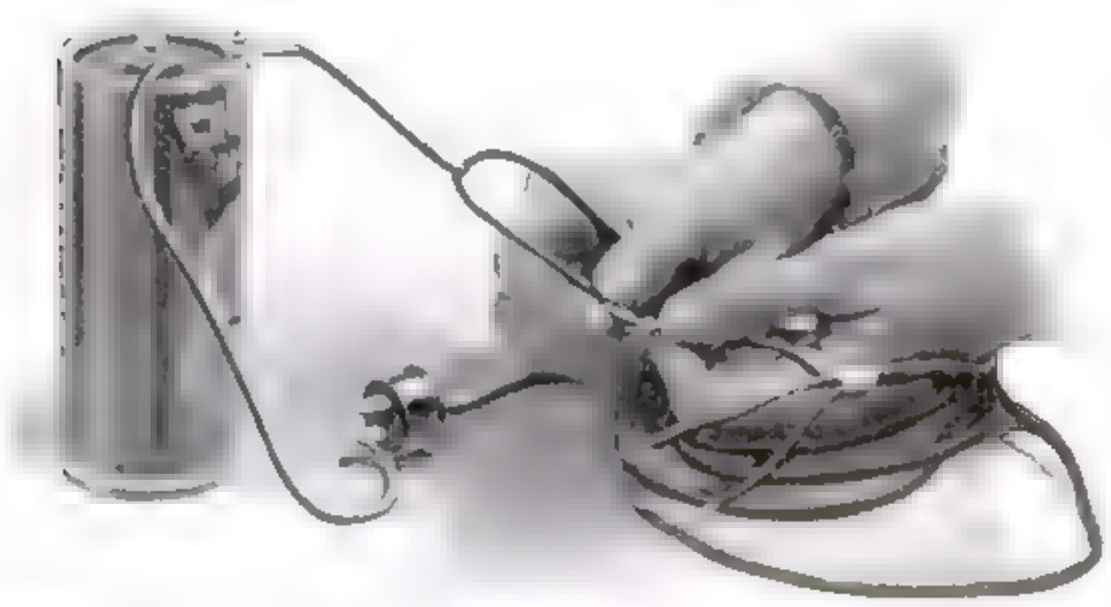
Having found the two leads which are connected together, the next step is to find which of the leads is the resistor. To do this, fasten the flexible wire to one of the prongs of the power-cable plug and touch the tip to each of the leads at the other end of the power cord to determine which prong is wired to the common leads. Then, substitute a flash-light bulb for the headphones and test the two leads again. The lead which will not pass enough current to light the bulb is the resistor.

Incidentally, this same simple headphone-battery hook-up can also be used as a check when constructing a receiver in which it is necessary to insulate variable resistors and other parts from the metal panel or chassis. If the flexible wire is connected to the panel and a click is heard when the phone tip is touched to the shaft of the part which should be insulated, it is a sure sign that the insulation job has not been a complete one.

In testing the amplifier, simply run a two-wire cord between the input binding posts of the amplifier and the headphone terminals of the receiver. The set is tuned exactly as if headphones were used, the volume being controlled by the volume control on the amplifier unit. Very little signal input is required to push the amplifier for full output.

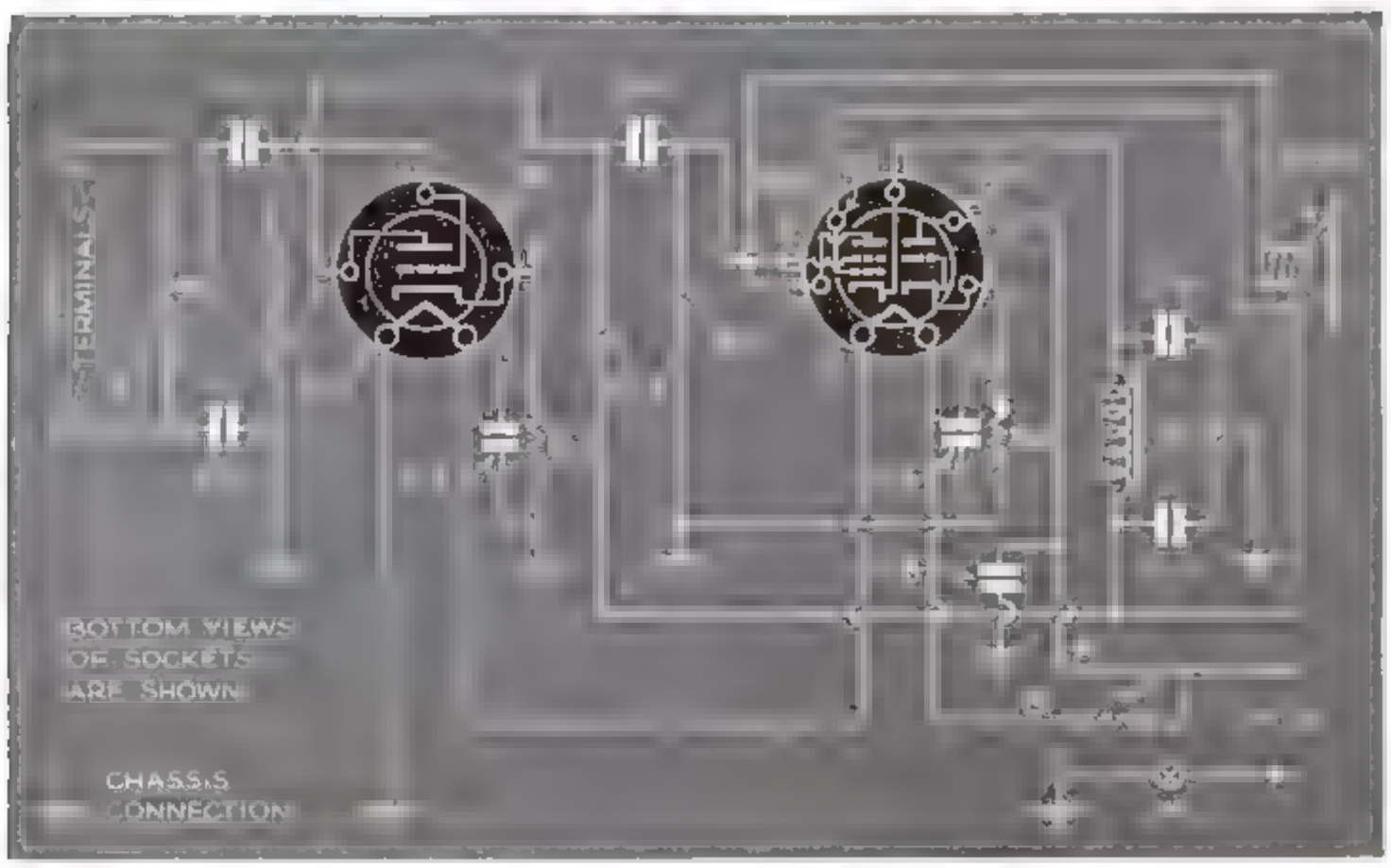
If the tubes light but the amplifier fails to operate when plugged into a direct-current line, reverse the position of the power plug. The polarity of the circuit must be correct in order for the outfit to function.

To make it easy to shift the amplifier from one piece of equipment to another, it is advisable to supply the unit with a cord fitted with headphone tips. If the amplifier is always to be used with one particular receiver, the two units can be interconnected permanently through a double-pole, double-throw switch. This will make it possible to use the receiver alone with headphones as well as with the amplifier for loudspeaker reception. The switch, of the toggle variety, can be mounted on the receiver panel.



TEST SHOWS RESISTOR LEAD

To find which of the three leads is the resistor, connect a tip of the headphone cord to one terminal of a dry cell and make the "continuity" test illustrated. The resistor lead is found by elimination



Wiring diagram for amplifier. The symbols correspond with those in the list of parts at the right

LIST OF PARTS

C_1, C_2, C_4, and C_5.—Fixed condensers, .01 mfd.

C_3.—Fixed condenser, .5 mfd.

C_8.—Electrolytic condenser, 5 mfd., 25 volt.

R_1.—Variable resistor (potentiometer with switch), 25,000 ohm.

R_2.—Fixed resistor, 250,000 ohm, 1 watt.

R_3.—Fixed resistor, 2,500 ohm, 1 watt.

R_4.—Fixed resistor, 150,000 ohm, 1 watt.

R_5.—Fixed resistor, 750,000 ohm, 1 watt.

R_6.—Fixed resistor, 1,500 ohm, 3 watt.

R_7.—Resistor (in power cord), 330 ohm.

C_6 and C_7.—Electrolytic condenser, dual, 8 mfd., 150 volt.

Ch.—Filter choke, 30 henry, 300 ohm or less.

Miscellaneous.—Five-inch magnetic speaker, 330-ohm power cord, metal chassis, wood-composition panel, binding posts, wire, solder, sockets, tubes, bolts, etc.

GUS says:

Give Your BATTERY a Chance

"Good grief!" exclaimed Gus. "What on earth are you trying to do?" Three dry cells were connected with the car's battery

"SO THAT'S the bunk they teach my boy at school!" Bill Simpson sputtered, shoving an elementary science textbook under Gus Wilson's nose as the garageman pulled into the Simpson driveway in response to a trouble call phoned to the Model Garage.

"See," he went on, pointing to a paragraph with a grease-stained finger, "it says that if you connect the negative pole of a battery to the positive pole of another one, the voltage of the two batteries will be added together and you get that much more voltage."

"Hold on a minute," the veteran mechanic grinned, as he climbed out and walked over to Simpson's car. The floor board was up, exposing the storage battery. The heavy cable had been disconnected from the latter and, by means of a piece of bell wire, had been hooked to the center terminal of one of a series of three dry cells standing on the running board. The other end of the series was connected, by way of another piece of bell wire, to the terminal of the storage battery.

"Good grief!" Gus exclaimed. "What on earth are you trying to do?"

"That's what I'm trying to tell you," snapped Simpson. "This book says you can get more voltage by adding batteries. So, when the motor wouldn't start because of the cold, I thought I'd just pep up the current by adding the door-bell cells. But it doesn't work at all. The blame thing won't even turn over the motor now."

"Humph!" Gus grunted disgustedly. "Sure would have been a miracle if it had worked. Trouble with you is you didn't read that book far enough. You didn't get to the part where it explains about electrical resistance. Electric current flows because of the pressure behind it, that's right enough, but the volume that flows depends on both the pressure and the resistance. Hooking those door-bell cells in like that raised the voltage a volt and a half apiece, just as the book said it would. Connect a voltmeter across that circuit and you get a 10½-volt reading—six from the storage battery and four and a half from the three dry cells. Here, I'll show you."

Gus fished a combination voltmeter and ammeter out of the service car and connected it between the end terminal of the three dry cells and the frame of the car. It read almost precisely ten and a half volts.

"Now," Gus continued, "I'll connect the ampere part of this meter across one of the dry cells. See, it reads only twelve amperes. And, if I connect it across all three of the dry cells like this, it still reads only twelve amperes. That means the resistance inside each cell limits the flow of electricity to twelve amperes of current.

"What you didn't know is that an auto-starting motor draws up to 150 amperes to turn the engine over, or even more than that when it's stone cold. That much current flowing on only six volts pressure means that there must be next to no resistance anywhere in the circuit. Take a look at the thickness of that starting cable—almost as big as your little finger, and only a couple of feet long. No resistance there. And the starting motor is wound with heavy copper bars instead of small wire, so the resistance in the motor is mighty little, too."

"Gosh!" Simpson exclaimed, as he fingered the heavy starting cable. "Looks like I was sending a boy on a man's errand, all right. I thought this cable was made heavy just so it wouldn't break. But why is it that a storage battery can give so much more current than that door-bell battery can?"

"Just the nature of the beast," Gus smiled. "The lead-acid storage battery has such a low internal resistance that it can supply far more electrical power for a short time than anything else of the same size and weight ever invented by man. In fact, if it weren't for that feature of a storage battery we'd still be experimenting with spring gadgets and compressed-air thingum-a-bobs for starting auto engines."

"Well, slap another battery in there, Gus," said Simpson, "while I cart these dry cells back and hook 'em to the door bell again."

"Hold on a minute," Gus objected. "Did the battery turn over the motor all right before you started monkeying with it, only the ignition wouldn't take hold?"

"Sure, that's it," Simpson agreed. "Just groaned over and over and nothing happened."

"Then," said Gus, "if you'd have hooked those three door-bell cells in the right place, you'd have gotten started without any trouble—here, let me show you.

"See that small wire leading up from the starter-switch connection?" Gus asked. "That wire carries the current from the battery to the *(Continued on page 127)*

By **MARTIN BUNN**

Cutting Out Thin Sheet Metal *with* Acid

By Philip R. Tarr

After being thoroughly cleaned, the metal is held in melted wax long enough for it to become warm so that the excess will drain away

DID you ever try to cut a delicate pattern from thin sheet metal without bending it? If not, perhaps you want to engrave figures or lettering on metal, such, for instance, as the numerals on a clock dial. Acid can be made to do both of these jobs without any disfiguration of the metal such as you would get if you tried to do the cutting or engraving by mechanical means.

Although not new, the process is often overlooked, yet every amateur craftsman should be familiar with it because it may be used for so many purposes. Suppose you wish to cut a metal sheet for the side of a miniature railway coach, with smooth, flat window sills. Acid will do it. Then you may want a neatly engraved name plate for a ship model, or a bookplate, or a fancy metal lamp shade. Acid will do the job again, and much more neatly than you could possibly hope to do it by the use of shears, files, or chisels.

Just try the method once to convince yourself. You'll find it handy for making metal ornaments or fine metal parts for models. Titles for stiff-backed books may be made this way, or special metal stencils for lettering, or even figures for framing. Silhouettes cut from polished copper and framed against a black background make striking and artistic wall decorations.

The procedure is simple, although certain precautions must be observed carefully. There are three major steps. First, you clean the metal and polish it as desired; then you coat it with a special acid-resistant wax. Second, you inscribe the design you want to cut out through the wax layer to the bare metal with a sharp scriber. Third, you immerse the metal in an acid bath especially prepared for the purpose, and soon the part or pattern is all neatly cut out, with no bent corners or ragged edges. All you have to do after that is to pull the unwanted parts away and clean the metal with gasoline. The individual steps will now be explained in detail.

HERE'S a process every amateur mechanic should know about . . . It can be used for making ornaments, silhouettes, parts for models, stencils, and other projects . . . Engraving is done in the same way

Preparing the Metal. Success with the method depends upon care in each and every step. Whatever finish the metal is to be given should be completed before the etching or cutting operations, especially when the metal is very thin. It would obviously be difficult either to polish or grain a delicate pattern in thin sheet stock after it has been cut. Where figures are to be etched into the surface of a metal plate, the same thing applies. Attempts to polish it after the etching would result in rounding the edges of the fine details, consequently marring the appearance somewhat.

After the metal has been grained or polished, it should be cleaned thoroughly with benzine in order to remove any grease or particles of dirt. If stray greases are present, they may cause the acid-resistant wax to pull loose during etching. If dirt particles are present, the acid will attack them and subsequently reach the metal at those points and will thus destroy the pattern, or at least blemish it. It is a good plan to wipe the prepared metal with a small piece of chamois skin just before it is to be coated with the wax.

The Wax Coating. There have been any number of formulas published for making acid-resistant paints and preparations for use in etching metal. Some of them are all right, others are not. For the most part they are unnecessarily complicated. Asphaltum paint will work, but is not adapted to tracing since it is black and smears easily when scribing through it. After experiments with a great many preparations, one was found which is unusually convenient and satisfactory. It consists of either syncera or ceresin wax. These waxes may be obtained from most large drug stores and

The metal parts, when etched, literally fall apart. The waste metal is shown in the background

from practically any chemical supply house. All you have to do is melt the wax, dip the metal in it and hold a moment so that the metal becomes warm and allows the excess wax to drain off. After the metal and wax have cooled, the wax layer will be quite hard and tough, and will stand a fair amount of handling or even bending. The most useful feature of these waxes lies in their ability to protect the metal from most acids, and they do not fray or come loose around the edges during either etching or scribing.

Inscribing the Design Through the Wax. The scribing operation consists of cutting the desired design through the wax layer with a sharp point. Small pieces of tempered and ground drill rod set in old pen handles make convenient tools for doing this work. If only one pattern of a kind is to be cut from the metal, then the pattern may be laid out on paper and traced onto the wax with typewriter carbon paper. The design is afterward cut through the wax with the aid of straightedges and French curves, or even freehand.

After the design is inscribed through the wax, the metal is ready for the etching bath A special solution is used to insure an even cutting action. It is slow acting but does a much better job than the baths often recommended for this purpose

The second operation, illustrated at right, consists of cutting through the wax layer with a sharp scriber point. Celluloid templates may be used if many parts are needed

If a number of duplicate parts are to be made, it is best to make celluloid templates as guides for the scriber point. These templates may be made by tracing the design upon the surface of thin celluloid with a sharp point and breaking the celluloid apart along the lines. The design should then be smoothed up around the edges with fine sandpaper and files.

An easy method for holding the templates firmly on the waxed metal while doing the scriber work is simply to coat them on the back with rubber cement. When this is dry, you may press the template in place; and when you are ready to remove them, you may do so without fear of injuring the wax by pulling it loose along with the template.

If the metal being used is only two or three thousandths of an inch thick, it is best to place it on a sheet of glass during the scribing, as shown in one of the accompanying illustrations. The metal will bend if backed by a soft surface, and the tool will also have a tendency to dig in badly.

Etching the Metal. We come now to the last operation except cleaning, that of etching through or into the metal as the case may be. The experiments previously mentioned have shown conclusively that it is useless for the amateur to try to do neat work with any kind of nitric acid bath. This acid, although frequently mentioned for such purposes, is unsatisfactory for the reason that it produces gasses when reacting with the metal. These gasses appear in the form of small bubbles along the crevices in the wax, and soon the wax is loosened and the fine detail is ruined. Even though one or two patterns are successfully cut, they will not be smooth and even along the edges

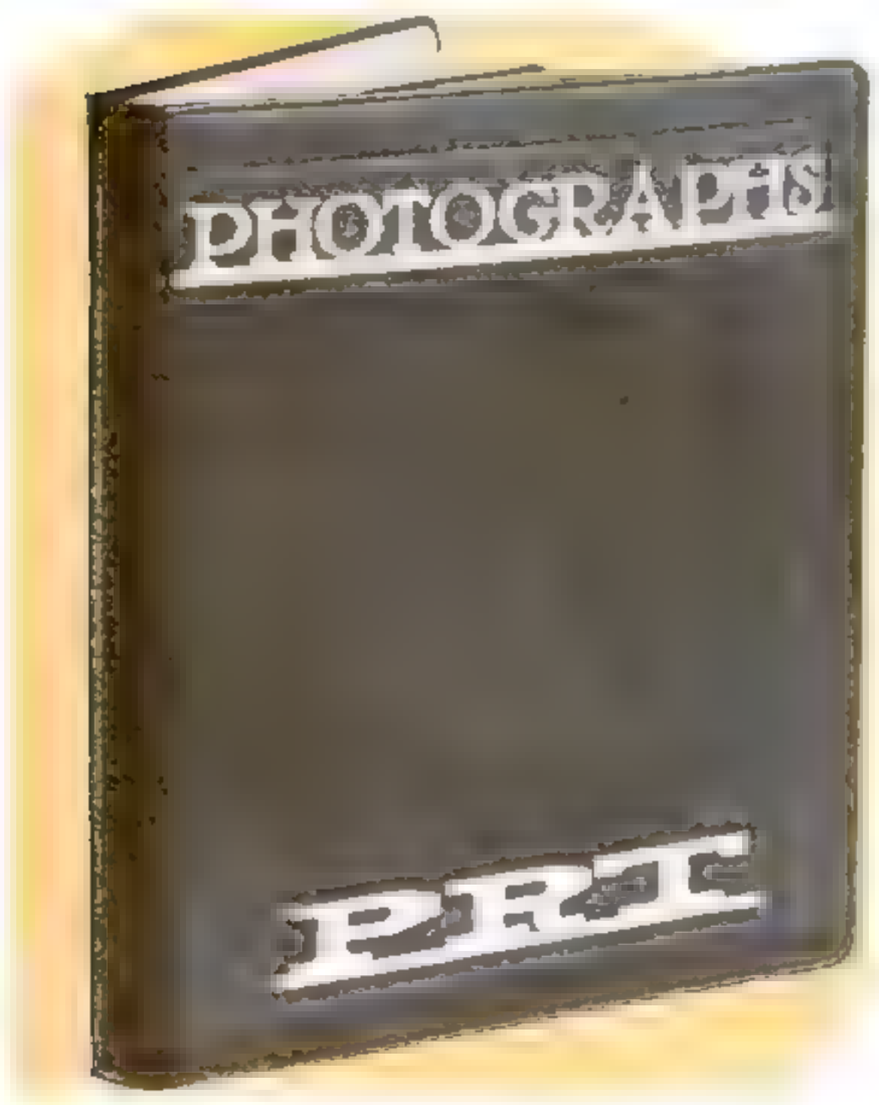
A special acid bath was developed which, although it is somewhat slow, works evenly and without the evolution of gasses. It consists of 3 oz. of potassium bichromate dissolved in 32 oz. of water, and then 3 oz. of concentrated sulphuric acid are added. So far this solution is the ordinary photographer's chromic-acid tray cleaner. In this form it does not have the power to wet through exceptionally fine lines. This power is given it by the addition of a very little emulsifying oil, obtainable at most drug stores. If none can be obtained, then a little liquid soap will do. The purpose of adding this is to lower the surface tension of the acid bath, or give it higher "wetting power," so to speak. There is another action taken by the soap, namely that of an inhibitor. That is, it slows the acid's action and at the same time causes it to act evenly all over the metal.

An acid bath of this type is suitable for use on brass, copper or steels other than the stainless variety. If aluminum is to be etched, this bath will work provided a little hydrochloric acid is added to the solution.

The etching should be done in glass dishes. With an etching bath such as that just described, you may put the metal in, rock the dish a few times, and then forget it for a couple of hours. Unless the metal is very thick, when you come back the pattern will be nicely cut out. It takes about two hours to cut through a piece of metal 1/32 in. thick.

All you have to do after the etching has been completed is to rinse the metal under the faucet and pull it apart. The wax may be removed by washing in gasoline or benzine.

At some time you may wish both to cut and engrave a design in thin metal. In order to do this, the outline is first scribed through the wax, the metal cut out as described before, and the engraving detail worked in with the scriber. The engraving then may be done by immersing the metal in the acid for a period of time equal to about half that required to cut clear through the metal.



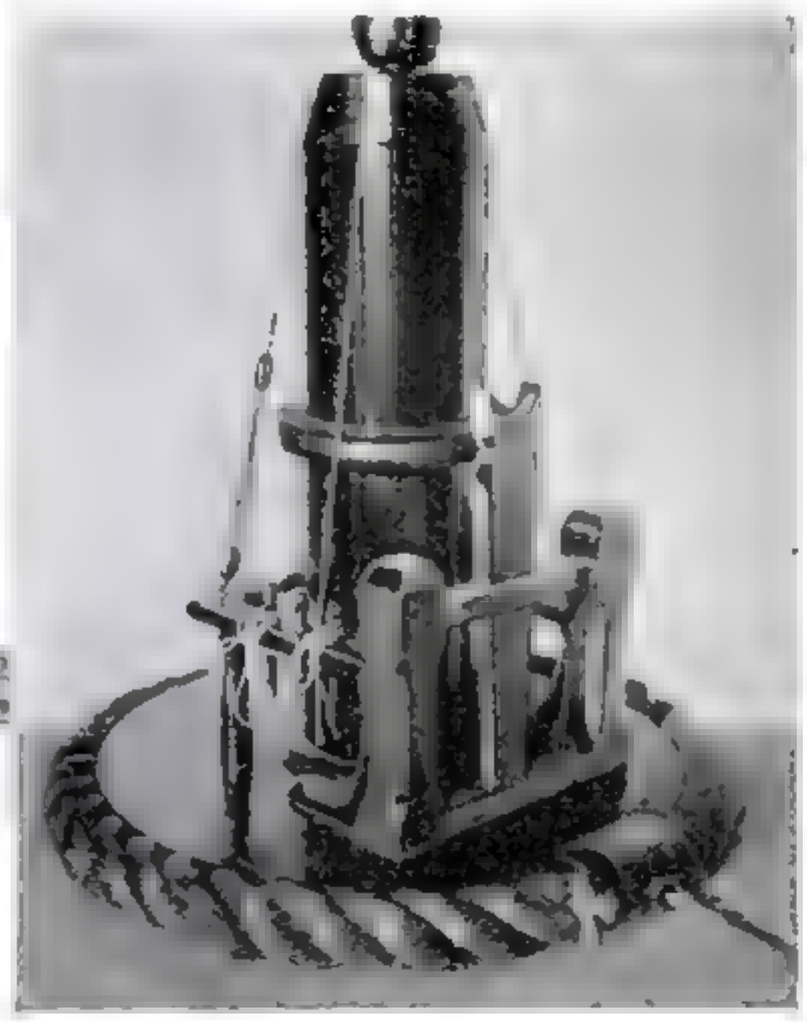
Metal lettering fastened to an album. The letters were attached with household cement and then coated with thin, clear lacquer

Unique Nautical Table Lamp

REPRESENTS A SCHOONER'S MAINMAST

By
John Patterson

The standard of this lamp is a carefully detailed scale model of the lower part of the mainmast of the same schooner painted on the rope-edged shade



The model is complete with bitts, stanchions, fife rail, belaying pins, and even the foreboom crotch

HERE is a table lamp that will appeal to any one interested in ships and the sea. To ship model makers, it offers an opportunity to construct something quite different from the usual line of models.

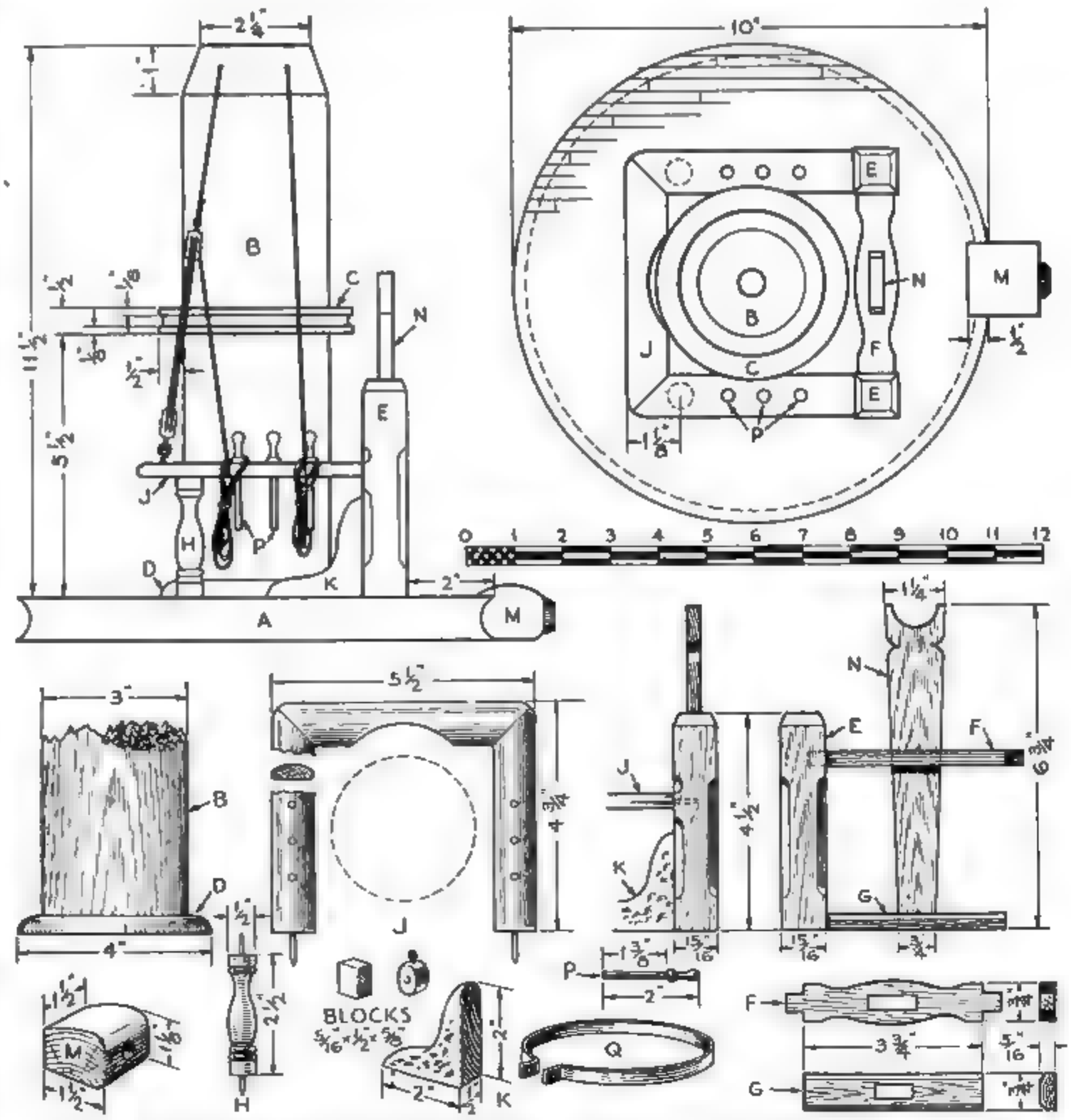
The standard represents the mainmast of a schooner, with the various fittings and a portion of the deck worked out to a suitable scale. A painting of the same schooner was used to decorate the shade, as shown in the photograph of the completed lamp.

The base *A* is a piece of ⅞-in. pine, turned on the faceplate of the lathe to 10 in. in diameter, with a circular groove around the rim ¼ in. deep. The topside, or deck, is ruled with lines ¼ in. apart to represent planking. This is best done with a glass cutter of the wheel type, and a pencil is afterwards run in the grooves to blacken them. The mast *B*, saddle *C*, and housing *D*, are all turned in one piece from birch or other hardwood. Note that the saddle has a ¼-in. groove around the rim, just deep enough to take the strap *Q*, which is made of brass and held in place with a bolt and nut through the out-turned ends. All metal parts may be given a coat of aluminum paint to represent galvanized iron, but brass, of course, looks much better on a model of this kind.

A ½-in. hole passes vertically through the center of the mast and through the base. Bore from each end to prevent the hole from running off center. The plug *M* is cut from pine and is set into the base ½ in. A hole passes through this plug and through the base to meet the hole in the center. A 3- or 4-in. piece of brass tubing is threaded into a standard pull-chain socket and secured in the top of the mast. The lamp cord runs down through the mast and horizontally out through the base and plug *M*. The hard rubber bushing which comes with the socket is removed and placed in plug *M* as a finishing touch.

The bitts *E*, stanchions *H*, knees *K*, crotch for foreboom *N*, and the pieces *F* and *G* are all made of pine to the dimensions given in the drawing. The knees are cut out with a pocket-knife to represent hand-hewn work. Make the fife rail *J* of black walnut, or a dark piece of mahogany. Glue and dowels—the latter made by cutting the heads off 8-penny nails—securely fasten the fife rail to the bitts, and the stanchions to the fife rail and deck. The knees are simply glued in place, while a countersunk screw through the base holds the bitts. The mast should be held to the base by two 3-in. screws in the same manner.

The *(Continued on page101)*



Side and top views of the lamp standard and details of the various parts, with a scale in inches

Sturdy Power Hack Saw Built at Low Cost

THIS homemade power hack saw has given satisfactory service for several years and has even sawed off several pieces of railroad iron, which shows that it is built for real work.

The stand is rigidly constructed from 1¼-in. angle iron and is braced with ¾-in. angle iron. The stand is 24 in. long, 10½ in. wide across the top, and 18 in. high. Six-inch band iron is riveted across the top to hold the vise, bearings, and the stop to keep the saw from dropping when through the cut.

The saw frame is made of ¾-in. square cold-rolled steel, measures 12¼ in. long inside, and takes a standard 10-in. hack-saw blade. It is 5 in. deep, and the end pieces that hold and tighten the saw are turned from ½-in. square cold-rolled steel. A square head is left for the saw, and the shank is turned down to ⅜ in., the whole length of the holders being 3½ in. The guides on the saw holders for keeping the saw straight can be seen in the illustrations and may be made from mild steel, drilled and ground to shape.

A slot for the saw can be sawed into the saw holders with the same saw that will be used in the machine. Piece of an automobile wind-shield wiper rod makes an ideal pin to fasten the saw at the ends. As this pin is quite hard, the saw will not cut into it.

The slides that support the saw frame are made from 1-in. square cold-rolled steel and are 2⅝ in. long. The slide rods are ⅝-in. round cold-rolled steel and are 10¼ in. long between end pieces. The slides and end pieces are drilled 1½ in. on centers; one piece is marked out and drilled, and that one is used as a template to drill all the rest by.

The bearings are ¾-in. pillow blocks bought from a large mail-order house. Two pillow blocks are used as main bearings, and a third is bolted to the angle-iron arm that is used to raise and lower the saw. This third bearing goes on the ¾-in. shaft between the main bearings, and is mounted upside down and bolted to the bottom of the angle-iron arm. The two main pillow blocks are supported on two hardwood blocks 5½ in. long and 3 in. high, the bearings and the wooden blocks being bolted to the 6-in. band iron.

The crank is made of 1-in. square cold-rolled steel, and the holes for the shaft and crank pin are drilled 2½ in. on centers. Designed to give the saw a 5-in. stroke, the connecting rod is made from ¾-in. square cold-rolled steel and is 9¼ in. long; it is turned down round between the heads.

Guides to help take the side strain from the bearing that holds the raising and lowering arm are made from 1-in. angle iron and are 10½ in. long. The guides are supported on a piece of 2-in. angle iron, bolted to the stand. Lead weights are cast in a wooden mold and are used as shown to serve as counterweights.

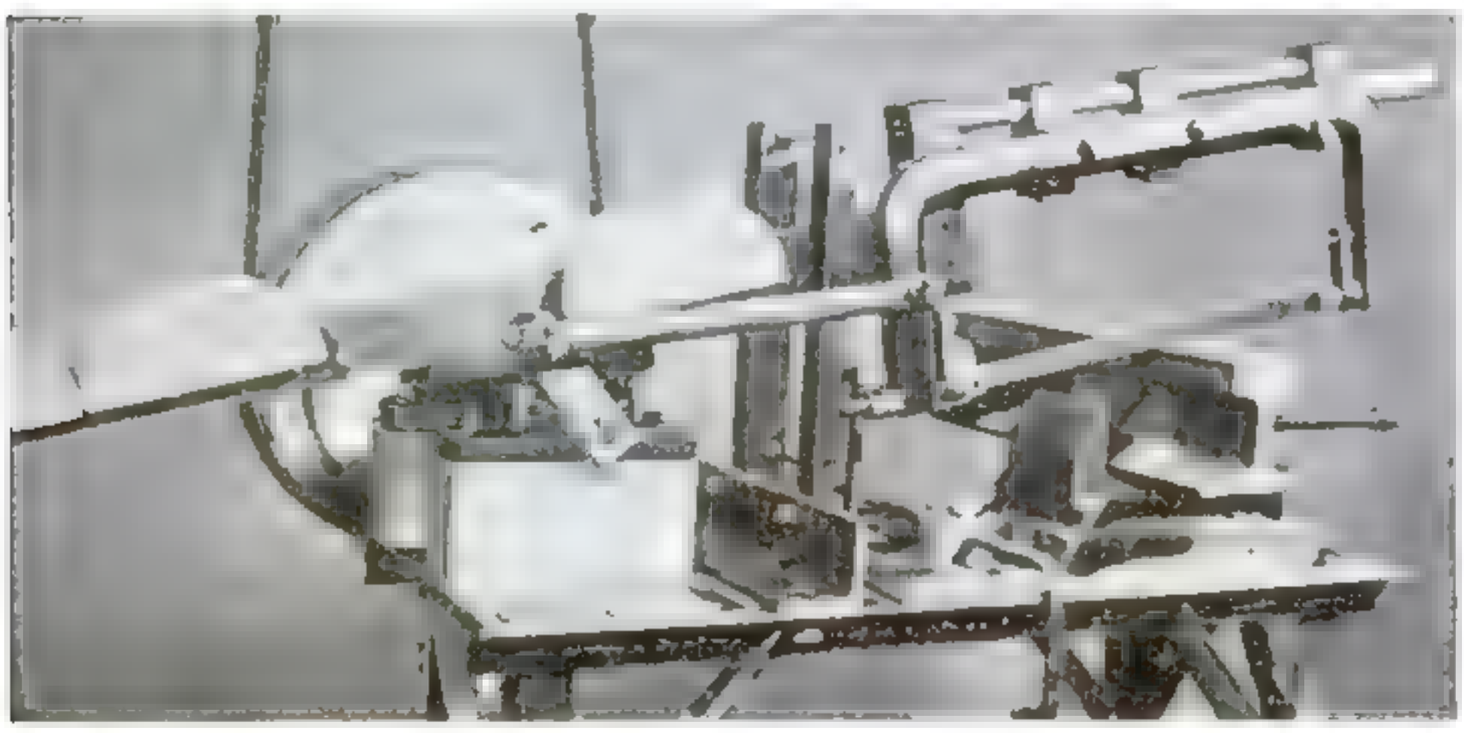
The saw itself, the vise, and the roller stand for supporting long stock are all shopmade

The pulleys are made of wood. The tight pulley is bolted to a flange, and the flange fastened to the shaft with a set screw. The loose pulley has a Babbitt metal center that runs on the shaft.

The vise to hold the work may be purchased or it can be made, as by the writer. A pattern was prepared and the casting ordered from a foundry.

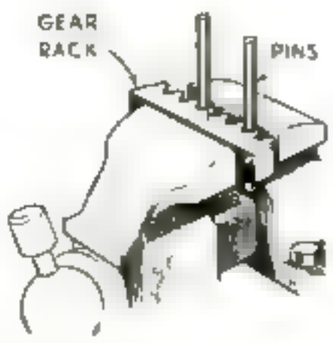
The stand to support long stock was assembled from pipe. It has a roller at the top, and an old automobile brake drum is used as a base.

With this brief description, I believe any machinist who wishes to add a similar power hack saw to his shop equipment will have little difficulty in working out the details of the construction. The dimensions may, of course, be changed to suit the builder's ideas.—HARLAND S. MARDEN.



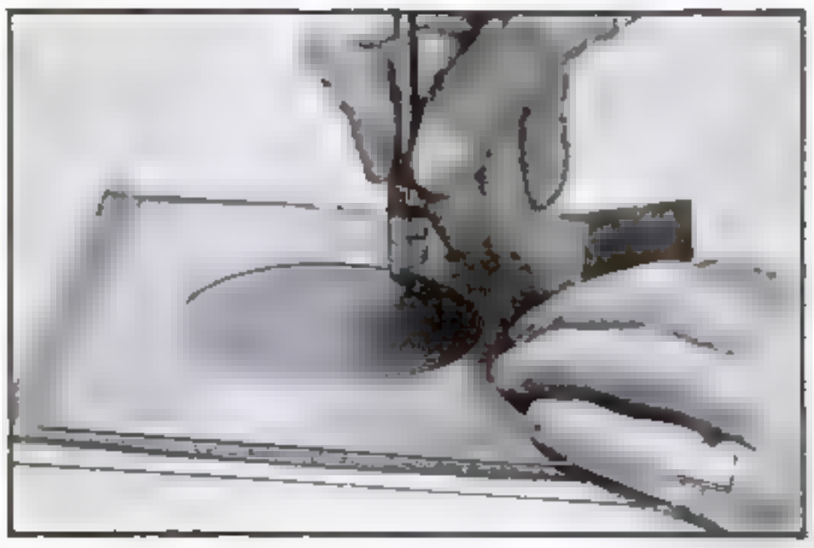
Even stock as heavy as steel rails can be cut without difficulty. Note the lead counterweights

BENDING JIG FOR VISE



FOR bending and shaping large wire or the smaller sizes of metal rods or bars, an improvised bending jig like that shown is useful. It consists of a portion of an old gear rack and two or more bolts or steel pins. The rack is placed along one jaw of the vise, and the pins are clamped between the teeth at the desired distance apart.—W. C. WILHITE.

GLASS CUTTER MAKES CURVED MASKS

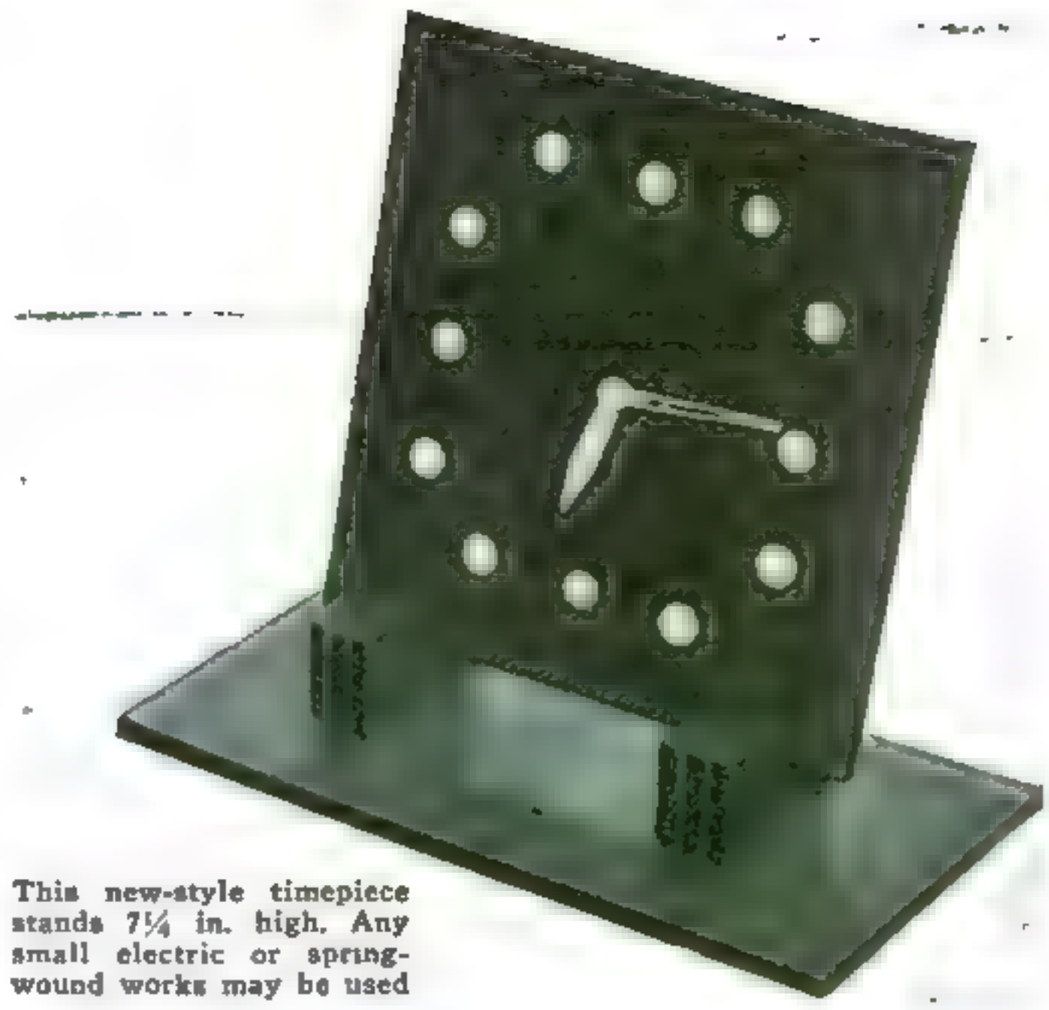


WHEN you wish to cut ovals or circles in paper, as in making black paper masks for photo printing, try using a glass cutter instead of a knife or razor blade. It will follow any curve with ease and make an absolutely clean cut. Place the paper on a sheet of glass, as shown in the illustration. If a number of masks are to be made, you can use a metal template as a guide. It is necessary, of course, that the cutter be in good condition and have a well-sharpened wheel.—E. A. BOWER.

Desk Clock
IN MODERN STYLE

The mounting is made in the simplest manner from a single sheet of highly polished, brilliant cast-resin material

By ALBERT Q. MAISEL

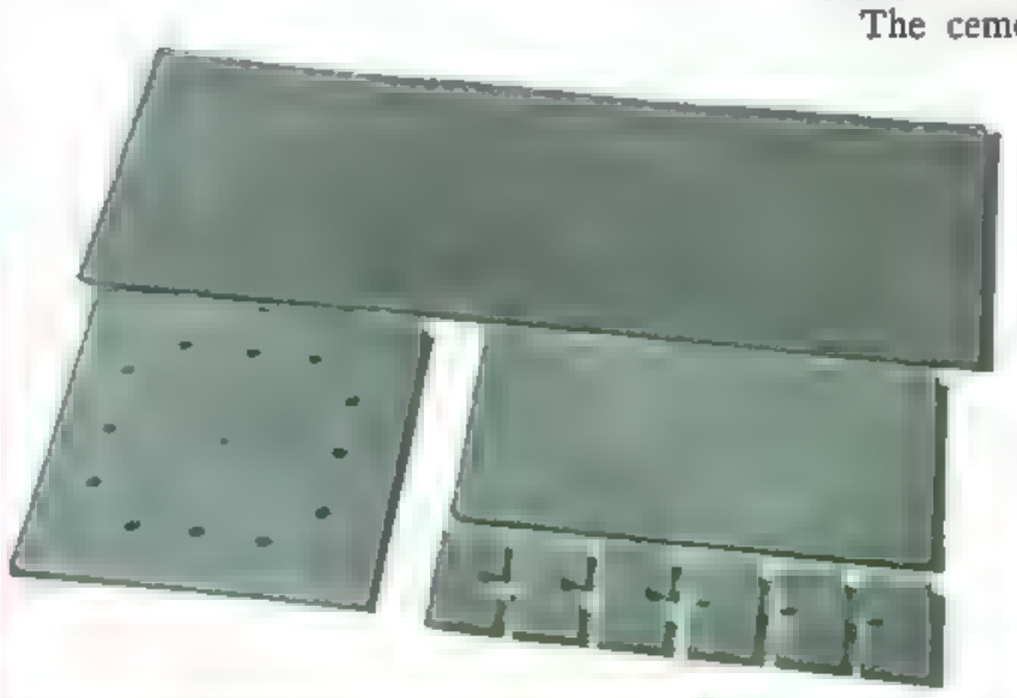


This new-style timepiece stands 7¼ in. high. Any small electric or spring-wound works may be used

WHILE clock movements themselves do not cost much, good modern designs in clock cases usually are quite expensive. The amateur craftsman, however, can produce a desk clock of cast-resin plastics like the one illustrated within a few hours, and in quality and appearance it will fully equal the commercially available types.

The materials required are a single 6 by 16-in. sheet of cast resin, ¼ or ⅜ in. thick, and a 5-in. length of round rod, ⅜ in. in diameter. The clock movement can be obtained from dealers who supply clock-making materials for amateurs or from a local watchmaker, or it can be taken from an inexpensive commercial type of clock. In the latter event, the cost need not exceed a dollar, although, of course, more expensive movements will give better and longer service. The one requirement governing the choice of a movement is that the stems of the hour and minute hands be sufficiently long to extend through the cast-resin panel forming the face of the clock, so that the hands may be fitted back into place without jamming. Either an electric or a spring-wound movement may be used.

From one end of the 6 by 16-in. sheet, cut a 6-in. square, preferably with a circular saw. A band saw may also be used, but care should be taken to prevent any "weaving" of the blade. In the exact center of this panel mark for a ¼-in. hole to take the time shafts of the clock movement. If a circular face is desired, draw a circle around this point, using a 2-in. radius, and then mark each hour division. Start directly above the central mark (for the 12 o'clock dot) and space the center of each succeeding hole 30 deg. farther around the circle. If you prefer the more modern square arrangement of the indicating dots shown, the same method should be followed, but then project lines from the central hole outward through each hour point towards the edges of a try-square set 1 in. within the edges of the plate itself. The layout for this type of face may be seen in the photograph of the unassembled parts.



Drilling the holes for the hour dots, which are cut from a rod of plastic material of contrasting color. At right is shown one way of cutting the grooves in the legs, the table being set ten degrees from the horizontal. The cutting wheel projects ½ in. The parts ready for assembly appear above

When all the holes have been marked, drill them with a bench or a breast drill and ordinary twist drills: The center hole is ¼ in.; the others, ⅜ in. Extreme care should be taken to see that all holes are perfectly centered, as the slightest deviation will be noticeable upon the finished, polished face.

With a circular saw, band saw, or even a hack saw, cut the rod, which should be of a contrasting color, into twelve ¼-in. lengths. These should be inserted in the holes after being daubed with cast-resin cement (obtainable from dealers in plastics). Place the face of the clock, front downward, on a sheet of newspaper backed by a sheet of thick cardboard or plywood; then insert each marker from the back so that it will be absolutely flush with the front of the faceplate.

The cement consists of the same material as the cast resin itself, but in an unhardened or uncured state. It is made to harden by adding about 6 parts of hydrochloric acid (USP) to 100 parts of cement. Mix up only sufficient for the job in hand just prior to using. To hasten hardening, the work may be placed, still resting on the newspaper and cardboard, upon two blocks set over a radiator. Drying time can thus be reduced from twelve hours to about three.

From the remaining part of the sheet material, cut a base plate 4 by 8 in. This will leave more than sufficient stock for cutting six small leg sections, each 1¼ by 1¾ in. These should be cemented together, in groups of three. Hold the blocks in position with small C-clamps while the cement is setting.

Either before or after cementing, it will be necessary to cut a groove, ¼ in. wide and ½ in. deep, in the top surface of the legs. This groove should slant at an angle of 80 deg. from the horizontal so that the face may be placed slanting slightly backward. A good method of cutting this groove accurately is to use a circular saw with a 4- or 5-in. metal-cutting blade. Set the revolving blade so that it extends ½ in. above *(Continued on page 100)*

Constructing Simple

This marionette stage constructed by Mrs. Drake is set up in a double doorway. The stage floor is of wood, and the puppeteer's stand or bridge consists of two soap boxes with a plank nailed on to serve as a platform

By Florence Fetherston Drake

IN THE *Language of Puppeteers...*

PROSCENIUM. *The picture frame or stage opening.*

FLY RAILS. *Rails on the upper stage from which hanging scenery is suspended.*

BACK DROP. *Screen of wall board or hangings (drapery) about 2 ft. back of the proscenium.*

BRIDGE. *Section where puppeteers stand when working the marionettes.*

TEASER. *Narrow valance above stage curtain. It is fixed and forms a straight line across the proscenium opening.*

STAGE CURTAINS. *These screen the proscenium opening.*

STAGE APRON. *Part of stage floor, usually curved, that projects in front of curtain. It is not always used.*

WINGS. *Sidepieces or narrow strips set at an angle, attached to the stage floor with clamps or suspended from above, and painted to accord with the stage sets.*

CYC. or CYCLORAMA. *A curved back drop, usually colored sky blue.*

PUPPET RACK. *Contrivance for holding the marionettes that are to be used in performances. The back part of the bridge is usually used for this purpose. In smaller theaters, clothes trees serve the purpose.*

MARIONETTE stages are of many types, simple and complex. If it were possible, I should have every one start with an outdoor theater. There is nothing more delightful, and it is quite easy of achievement.

We shall begin, however, with a small portable stage that may be used in the average doorway (marked Fig. 1 in the drawings). It consists of the frame, proscenium, back, back drop, two wings, and a bridge formed of two soap or apple boxes. A plank should be nailed across these to prevent their slipping. This stage is designed to be used on a kitchen or card table, the top of which forms the stage floor. Clamps are needed to hold the front and back upright parts firmly to the table.

From the top of the doorway to below the top of proscenium, a screen of some kind is needed (Fig. 9). This may be a window shade or a drapery. A similar one should be used from the table top to the floor.

The stage curtain may be drop, draw, or draped, as you prefer (Figs. 2, 4, and 7). The drawings show the details of the two former. The draped curtain is so rarely used, no description of it is given.

Draw curtains are those hanging in folds and separating in the center. Whatever material you use should be light in weight and lightproof. If not the latter, they will need to be lined—an unnecessary trouble.

If properly dyed and brushed, unbleached muslin makes a delightful curtain, having the effect of rich old velvet. Never, however, use real velvet, as it deadens the sound of the speakers' voices. The fabric chosen should harmonize in color with the proscenium. Cut two pieces about 10 in. more than half the width of proscenium opening and about 4 in. longer. Allow a few extra inches for hems on all sides.

Eight or nine rings are sewed to the top of each curtain where pleats are made. The rod or wire on which the curtain hangs is held by a screw eye at each end, and one in the center. Place the rod 2 in. above the arch so that the rings will not be seen by the audience. The rings should slide freely, therefore if wire is used, it must be very taut. A small turnbuckle at one side may be necessary.

THE teaser, or valance strip, if used, should be cut about 6 in. deep, and long enough to be either gathered or pleated. It is tacked across the top arch of the proscenium so that about 4½ in. show. This is, of course, immovable and should be fixed in place before the curtain is arranged.

To rig a draw curtain, cut a piece of stout cord about two and a half times the height of the proscenium, and wax it thoroughly with paraffin. Tie one end, for the time being, to a nail at the lower left side of the back of the proscenium; then thread the free end through screw eye *A* in Fig. 4, pull the cord tight, and sew it to curtain ring *B*. Be careful not to pull the curtain away from the center. Pass the cord through screw eye *C*, then bring it over to *D* and sew it to the ring, which also should be at the center of the proscenium. In other words, the curtain should be entirely closed. Now pull the cord tight. These two center rings should meet very closely in the middle. Finally, carry the cord through screw eye *E*.

Now that the curtain is rigged, free the end of the cord from the nail, and attach a small sinker or other weight here and at the other end of the string. The curtain then should open when *G* is pulled and close when *F* is pulled.

Marionettes are operated by strings from an elevated platform behind the back drop, called the bridge. It should have a rail in front, on which the operator leans and rests his arms when working the puppets (Fig. 3). Another rail at the back prevents operators from inadvertently stepping off the bridge. It also gives a place to hang puppets when not on stage by means of S-shaped wires. The back drop, which should, where possible, be higher than the proscenium and broader as well, screens the puppeteers' bodies and legs. The floor of the bridge should be 10 to 20 in. higher than the stage floor and about 18 in. wider if possible. It may be formed from two or three apple boxes nailed to a plank, or by two small step-ladders held together by wide boards and braced.

A stage set up in a double doorway is shown in one of the photographs. It can also be used independently, with screens

Marionette Stages

or draperies forming the sides and top.

The proscenium arch is cut from three-ply wood and braced by strips of wood in back. Chinese gold paper covers the front, and a decorative mask adorns the center. The wooden floor is covered with grayish tan duvetyn drawn tightly over all edges. Its neutral color makes a good ground color, and the fabric has the advantage of deadening sound, so the marionettes move over it noiselessly.

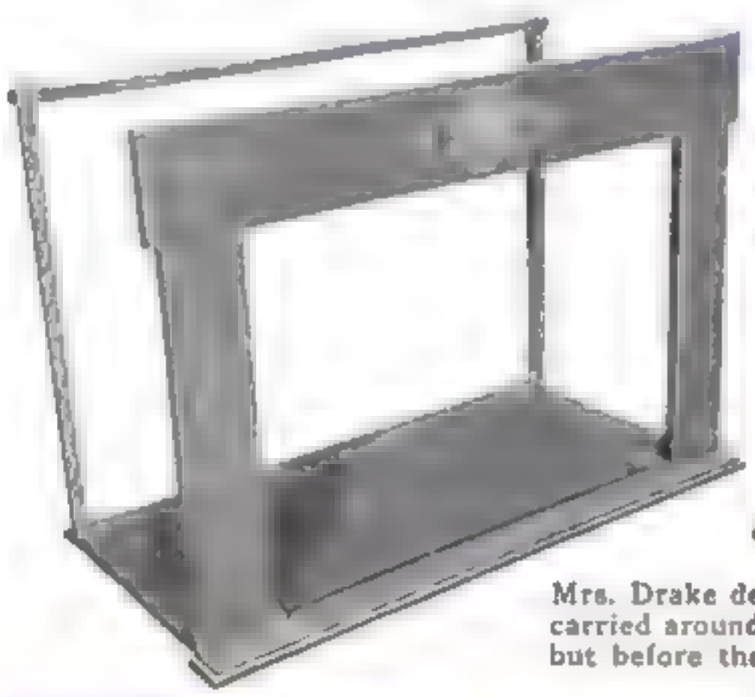
The curtains are made of a closely woven soft silk fabric—a warm tan color. Its sheen gives it a pleasing metallic light.

At either side of the stage floor at the front is a plug for a small standing stage lamp, called "olivette." A reflector, 6 in. in diameter, on an extension cord can be used from the top or lower part of the stage, as desired. Footlights are no longer used on the real stage, and few marionette theaters have them. They are considered to be old fashioned and inartistic.

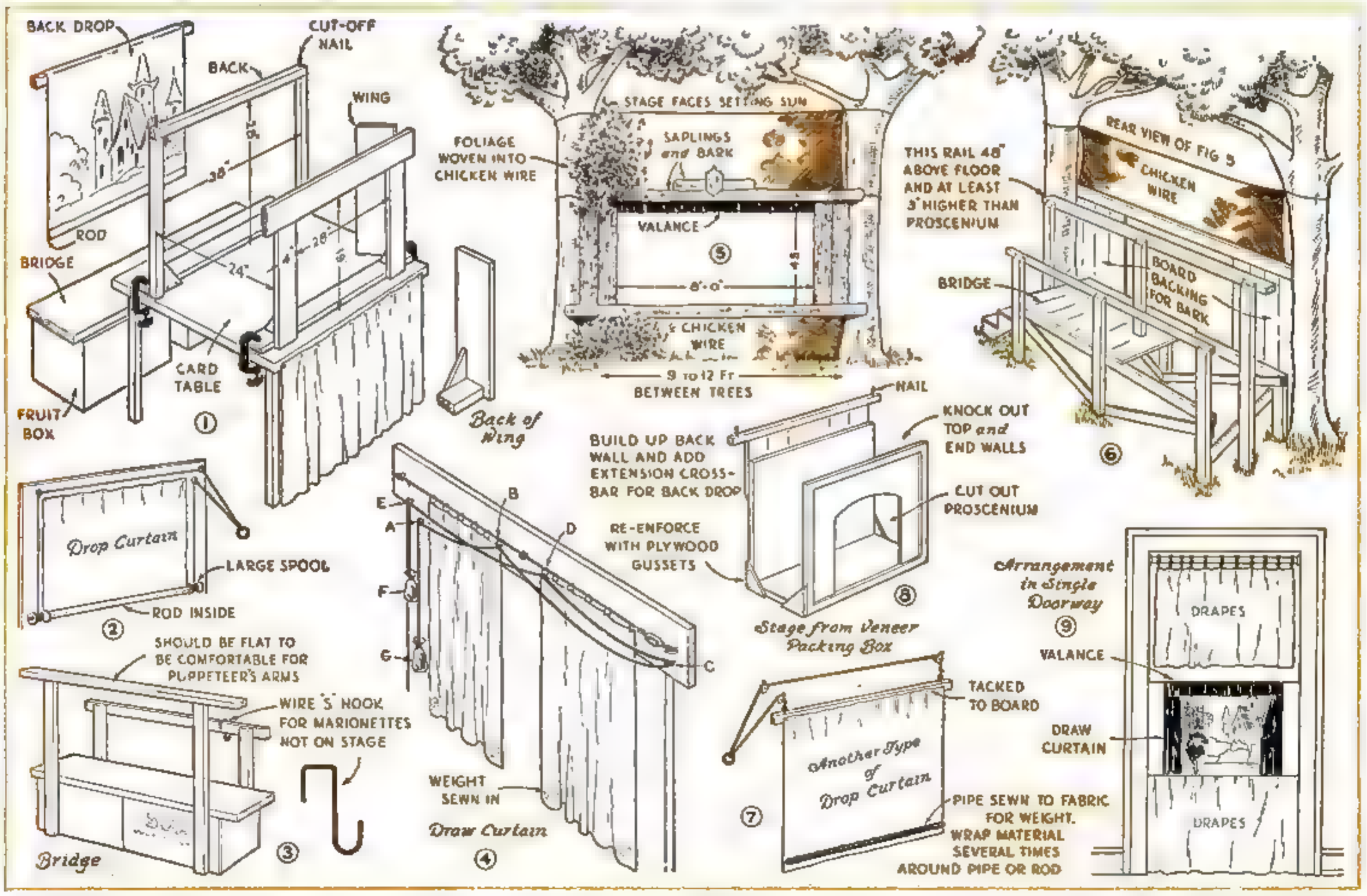
An out-of-door stage can be set up between two trees as in Figs. 5 and 6. Stout wires and chicken netting are nailed to the trunks to support the framing. In the netting are woven branches (preferably hemlock) above the proscenium and at the sides. Have an opening 45 in. high and at least 7 ft. 6 in long if possible. This height is three times that of a 15 in. marionette, but 24-in. puppets may also be used. The floor, which is made of tongue-and-grooved boards, should be about 2 ft. high and 2 ft. deep. No matter how long or high you make your stage, it must never be over 27 in. deep, which is about the length of the operator's reach.

Outdoor effects are easily achieved in a theater of this kind. Rocks, small bushes,

(Continued on page 105)

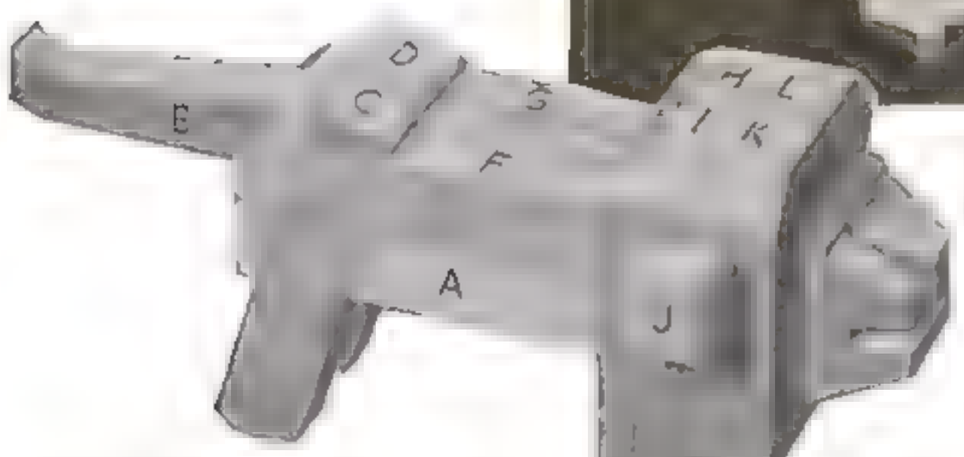


Mrs. Drake demonstrates the ease with which her portable stage can be carried around when closed. At the left is the same stage set up for use but before the curtains, back drop, and various accessories are added



Sketches showing the general arrangement of a marionette stage for use in a doorway; a bridge, various curtains and drapes, and an outdoor stage

Block Puzzle *in* Form *of* Ethiopian Lion



This "Lion of Judah" puzzle is a decorative little novelty

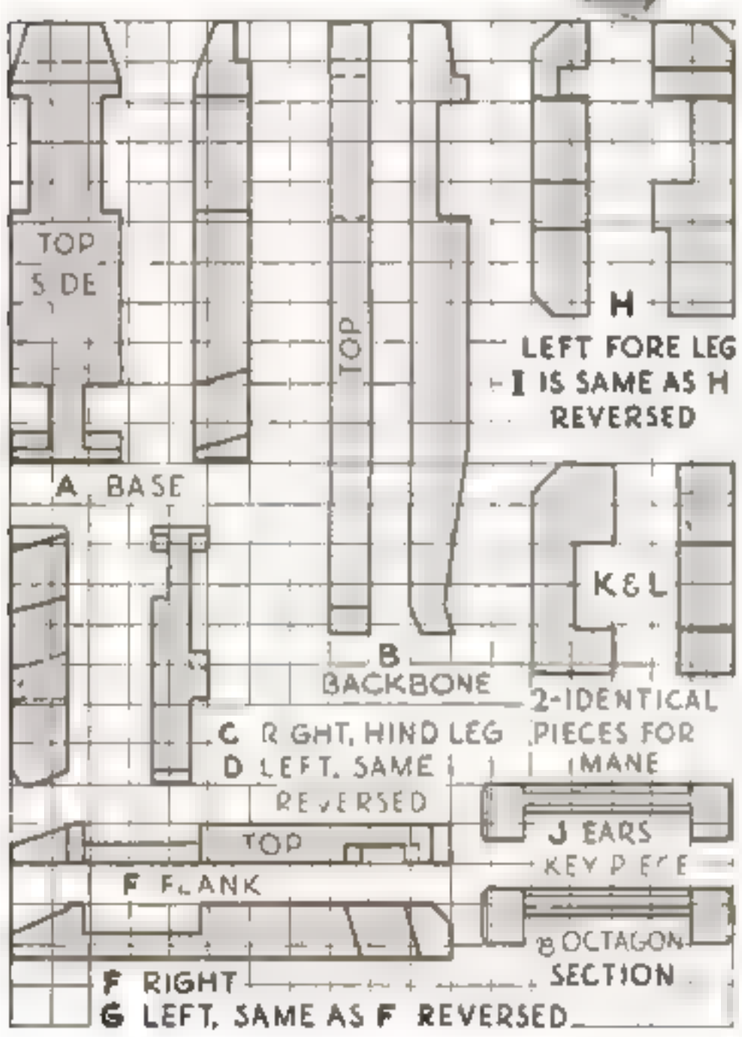
The eleven parts of the puzzle are sawed and whittled so they interlock

THE "Lion of Judah," familiar symbol of Ethiopia, is now represented in a new block puzzle that originated in the Orient. It forms an entertaining project for whittlers.

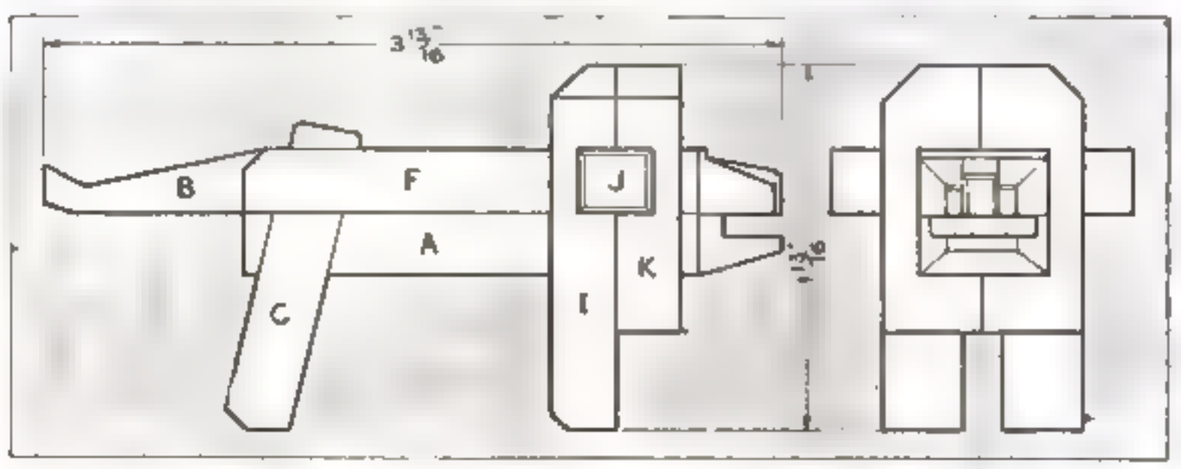
A close-grained hardwood such as maple gives the best appearance, but white pine, of course, is much easier to work. First prepare several long pieces, ¼ by ⅜ in. and ⅜ by ½ in., from which to cut out the various members as shown in the squared diagrams. If a saw is used, it should be fine-toothed, but if no saw is available at the moment, the entire job can be done with a sharp jackknife.

There are only eleven pieces, with *A* as the base or "chassis." Make this first, fitting the other pieces successively as you go along. Follow with *B*, which is the backbone, ¼ in. wide. Next come the hind legs *C* and *D*, the flanks *F* and *G*, then the forelegs *H* and *I*. Note that the ears *J* have the connecting bar cut to an octagonal section to enable it to be turned easily. This is the piece that locks the entire structure together, the ears being turned to lap over the mane pieces, *K* and *L*.

If the work is done on a circular saw (with very fine teeth), a quantity of the novelties can be turned out quickly for sale, once the master pattern has been completed.—K. K.



Side and edge views of each of the parts are given above exactly half size. The squares represent ¼ in. The assembled puzzle is as shown at right, with parts identified by letters



INSECT-HOLDING NEEDLE FOR MICROSCOPE STAGE

ANY amateur microscopist who has struggled with the problem of manipulating a small insect so that it could be studied from all angles will find useful a gadget similar to the one illustrated below. It can be made of any material at hand. A small block of softwood (pine or balsa) or cork glued to a piece of stiff cardboard or cigar-box wood, with a darning needle or a long glass-headed pin stuck through, will serve very well.

Those who wish to make a more elaborate attachment can indulge their inventiveness. The device shown is made of old radio parts—a binding post, two nuts from a dry cell, and a piece of hard rubber panel.—B. G. S.

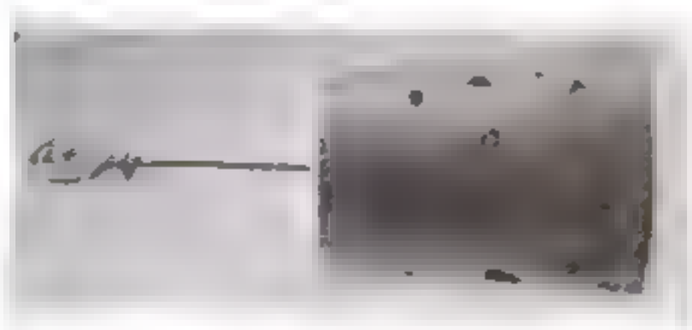
A needle mounted by means of old radio parts enables insects to be turned in any position

TWO CAN COVERS FORM ADJUSTABLE AIR VENT

A SMALL adjustable air vent may be made, when necessary, from two vacuum or compression can lids. They are laid off in eight sectors, and every other one is cut out with a chisel. One lid is fastened to the screened opening; the other is attached with a bolt, two nuts, and a small spring so that it can be turned as required, yet will remain in whatever position it is set.—FRANK W. BENTLEY, JR.

WATER GLASS MAKES SMALL, POWERFUL MAGNIFIER

A MINIATURE hand magnifier can be made in an emergency as shown at the right. Form a small loop in one end of a piece of copper wire and fasten the other end in a cork. Dip the loop in water glass (sodium silicate) and place in a level position to set. It will form a powerful little lens.—C. L.



MODERN

Mail-Plane Model

NEEDS ONLY TEN SIMPLE PIECES

By Donald W. Clark

A view of the little plane suspended as if flying and, at left, the parts. The wing spread of the model is 18 in.

AMONG the two dozen or more airplane designs given in this series have been included army and navy ships, commercial and passenger transports of both land and water types, racers and sport planes, and others designed for general use, but this month we are offering something different—plans for making a simplified model of a modern mail plane.

It is an all-metal, low-wing monoplane, designed particularly for mail carrying. There are two loading hatches on the forward part of the fuselage to facilitate the speedy handling of the mail. Known as the Northrop Gamma 2-D, it is powered with a Wright Cyclone engine rated as 710 horsepower at 7,000 ft. The maximum speed is 224 miles per hour, the cruising speed 215, and the landing speed 60. The service ceiling is given as 20,000 ft., the rate of climb as 1,200 ft. per minute, and the cruising range as 1,700 miles.

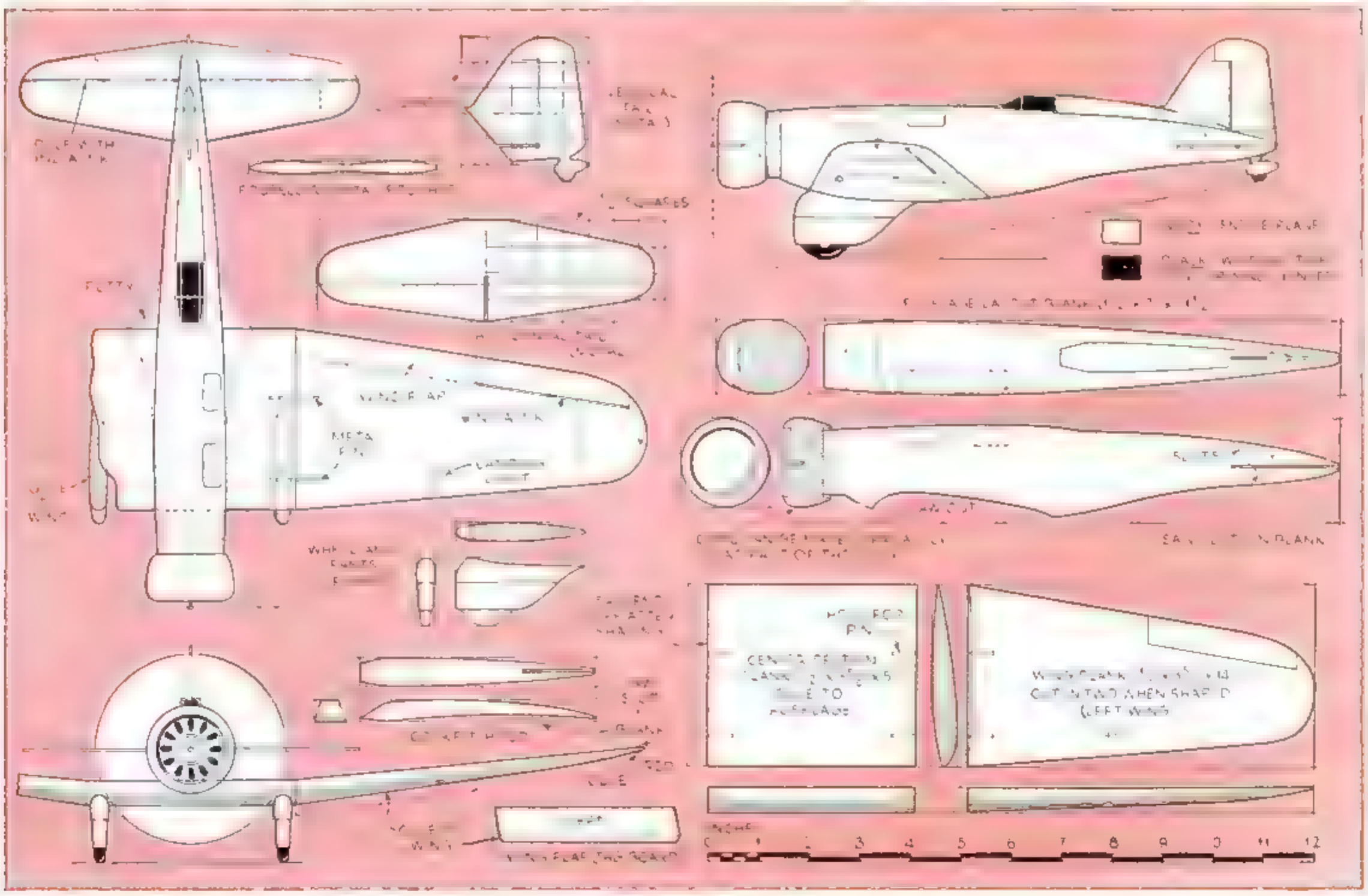
The center section of the wing is fastened in a recess cut accurately into the fuselage

The wing span is 47 ft. 9 in., the over-all length 31 ft. 2 in., and the over-all height 9 ft. The scale of the model in comparison with the full-size plane is ⅜ in. equals 1 ft.

Only ten simple parts are required to build this model. The engine cowl can be made separately and glued on, or it can be included as part of the fuselage block, as shown in the photographs. All slots should be sawed in the blank before any whittling is done. The fillets can be shaped with putty. Mark the contour of the fillets on the body and wing and roughen the surface with a pointed tool so the putty will hold fast.

Instead of using a tube spacer for the propeller, it will be easier to wrap thread around the shaft and add a touch of glue to hold the ends. Polish the propeller with fine emery cloth.

The color of the entire plane is ivory, with details such as the windows, tires, cowl openings and hinge lines indicated with black paint.



Working drawings of the model. The size of the fuselage and wing blanks is given, and other dimensions may be found by using the inch scale

PLANS FOR A Prize-Winning

How to duplicate the simple but beautiful piece that won first place for handmade furniture in the National Homeworkshop Guild's great contest

The judges in the Guild's national contest, one of whom is shown studying Mr. Keysor's table, rated it highly for design, craftsmanship, and finish

By H. C. KEYSOR

Member of the La Grange (Ill.) Homeworkshop Club

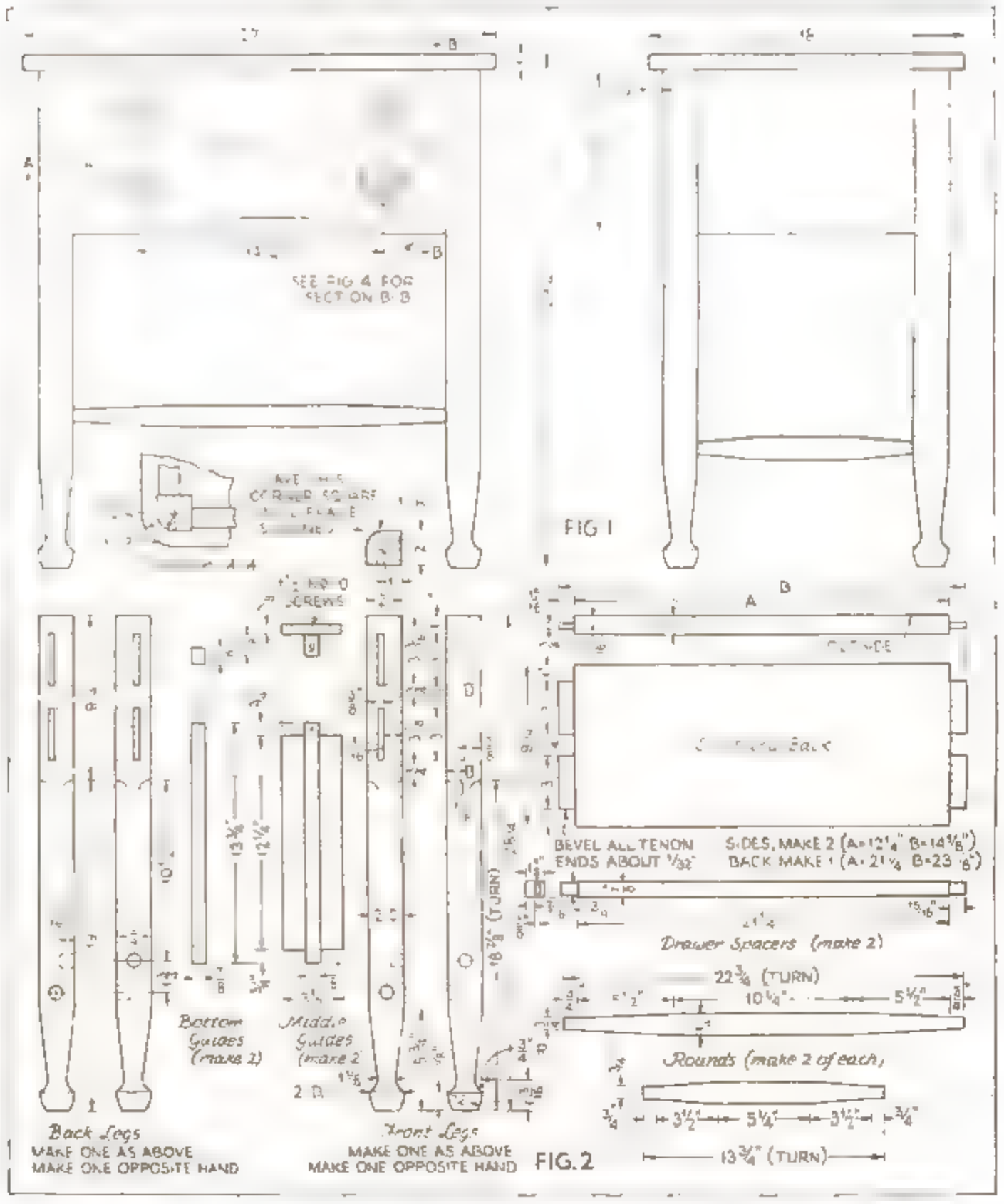
THE home workshop fan usually spends much of his shop time in making various gadgets which his wife considers quite useless. He has urgent need of a new tool cabinet, and that old tea cart will serve very well as a telephone stand. An excellent argument, but it fails to convince. He has one tool cabinet—what on earth does he want another one for? And the tea cart will positively not do any longer for a telephone stand.

So a telephone stand was scheduled for production, rush! It had to be about so long and so wide, design colonial, something like that one we saw at the World's Fair, with two drawers. One drawer was for the phone book, pencil and paper; the other was for—well, never mind what. It would be full, anyway, that was a certainty.

I took pencil and paper, racked my memory to conjure up a picture of the aforesaid table at the Fair, and made some free-hand sketches. It had to be walnut, my favorite cabinet wood, so that settled the material. I had a walnut board 28 in. long with handsome butt grain at one end, left over from a previous job—an ideal piece for the top—and thus the length was determined. A friend, who has a habit of collecting pieces of walnut lumber from odd corners of the country, had given me some 2¼-in. walnut well suited for table legs. Some pieces of quartered white oak (also left over) fixed the size of the drawers, and the rest of the design was easy.

I give below some brief notes on the making of this telephone stand, with the thought that the reader may wish to make one, as I did, with hand tools. Woodworking machinery will, of course, shorten the time required, but the pleasure of creating something and the solid satisfaction in the final result is likely to be less than for handwork. A handmade piece can be produced that will compare favorably in accuracy with machine work, assuming that the maker has reasonable skill and patience, and follows the fundamental principles of cabinetmaking. I emphasize this fact because there is a widespread fallacy that machinery is essential for accurate work. A lathe is, of course, indispensable, but wood turning is, in fact, handwork requiring considerable skill, although performed on a machine.

Whether or not he possesses machinery, the home worker enjoys at least one advantage over the largest and best equipped factory. Labor costs do not bother him, nor does he have to make a thing to suit salesmen or customers. He is king, supreme and absolute, over the whole process, from rough sawing the first piece to carting the finished product upstairs and surveying it over a good cigar while he plans, with his wife, just where to place it. He can make the highest craftsmanship his goal, using fine wood, mortises and tenons, and dovetails to his heart's content, and relegating to the lowest inferno such abominations as nails, putty, dowel pins, and poor wood. If he had to sell his piece of furniture at a price anywhere near that of the factory product, his hourly wages would be close to absolute zero, but he does not have to sell it, and he had lots of fun and satisfaction in making it, so time and wages are to him



Walnut Telephone Stand

questions of not even academic interest.

Being master of the design, he can make the piece with the extra strength that withstands rough handling by movers or the accidental dropping of a drawer; he can use stock of ample thickness to give the additional weight so desirable in small pieces; he can smooth and wax both drawers and slides, thereby avoiding that most annoying thing—a drawer that sticks; and, finally, he can finish the underside of the piece sufficiently so that he will not dread to have it inspected bottom up by some friend afflicted with the same hobby, a thing which said friend is certain to do.

I assume that any one who considers making a small table of the design given here, has had some experience in woodworking, so I shall not bore the reader with a long and tedious description of every step. Instead I shall mention merely those points of particular interest and importance.

The material should be of the best quality, thoroughly seasoned and preferably kiln dried. Walnut, mahogany, or maple may be used, or, if the hobbyist has the money, rosewood or vermilion wood. If possible, all the pieces should be taken from the same lot of material so as to secure a good match in grain and color; if this is not done, it may be necessary to tint the lighter colored pieces with stain to match the darker ones, an operation that is not easy for the amateur to do well. Wide pieces sawed clear across the log are apt to warp, even if well seasoned, due to changes in atmospheric moisture. Most of the warping occurs in the part nearest the log center; the edge portions are the best. Such a piece, if used for the top or sides, should be ripped in half and glued.

IF YOU LIKE TO WORK WITH wood and especially if you enjoy making furniture, you'll find a wealth of helpful, friendly hints in this article by Mr. Keysor. Among the country's greatest amateur furniture builders, he ranks No. 1 in respect to hand-tool construction. He gained that honor when first prize for furniture made with hand tools was awarded him at the National Exhibition and Contest of the National Homeworkshop Guild in Chicago last year.

The prize-winning piece was the very same walnut telephone table about which he now writes. The design is simple, there is nothing fancy or elaborate about the piece, but the craftsmanship and finish are superb. Rufus C. Dawes, chairman of the board of judges, and his seven colleagues were agreed that Mr. Keysor turned out not only the finest piece of handmade furniture, but also one of the most beautiful and distinguished examples of craftsmanship in the entire exhibition.

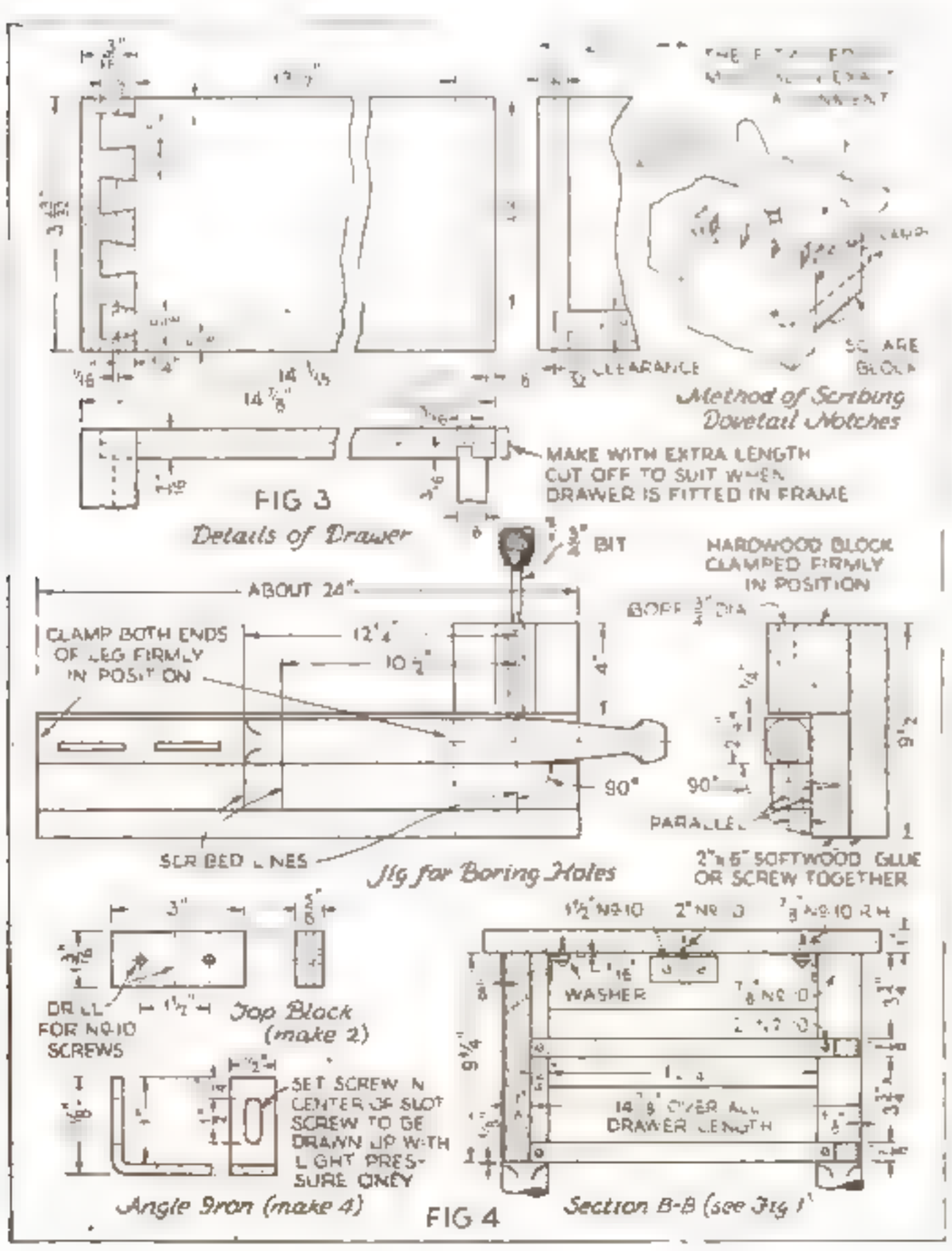
The tools required are those found in any ordinarily complete outfit. Good bar clamps are essential, also a scraper plane, and a dado plane for grooving drawers. A machinist's adjustable try-square (which is much more accurate than the usual carpenter's try-square) is desirable. A 24-in. ground steel rule is also very useful for making glue joints and testing pieces for straightness.

In order that the piece, when joined, shall come square and true with accurately fitting joints, it is absolutely necessary that the component pieces shall be geometrically correct. That is, pieces which are supposed to be square, straight, and flat must actually be so. The pieces must be finished with the scraper plane and worked down till they check true with square and straightedge. The use of an accurate small level in conjunction with the straightedge will show if a piece is winding, and any such winding or warping must be planed or scraped out. If you buy your stock finished to size from a planing mill, don't take it for granted that the pieces are straight and square because machine cut. They will probably require to be trued with plane and scraper. Failure to observe the above precautions is responsible for most of the trouble and poor work turned out in the home workshop.

An accurate butt joint can be made easily if the stock pieces are true and a good plane is used. The plane should be at least 22 in. long and the blade ground with a perfectly straight edge. A convex or concave edge will make a good joint impossible; no amount of skill will overcome this obstacle. After whetting the edge to razor sharpness, check it against a steel straightedge. The joint must fit light tight without clamp pressure and without any rocking. My preference is for a first quality hide glue, soaked in pure soft water and heated not over 160 deg. F. (higher temperatures seriously impair the strength of the glue). Do not keep glue hot any longer than necessary—heat is a necessary evil in gluing, hence the less the better. The wood should be warmed before applying the glue. Most prepared liquid glues are to be avoided for work of this kind; however, I recently discovered a liquid airplane glue which has strength equal to good hot glue, and which, of course, is easier to apply.

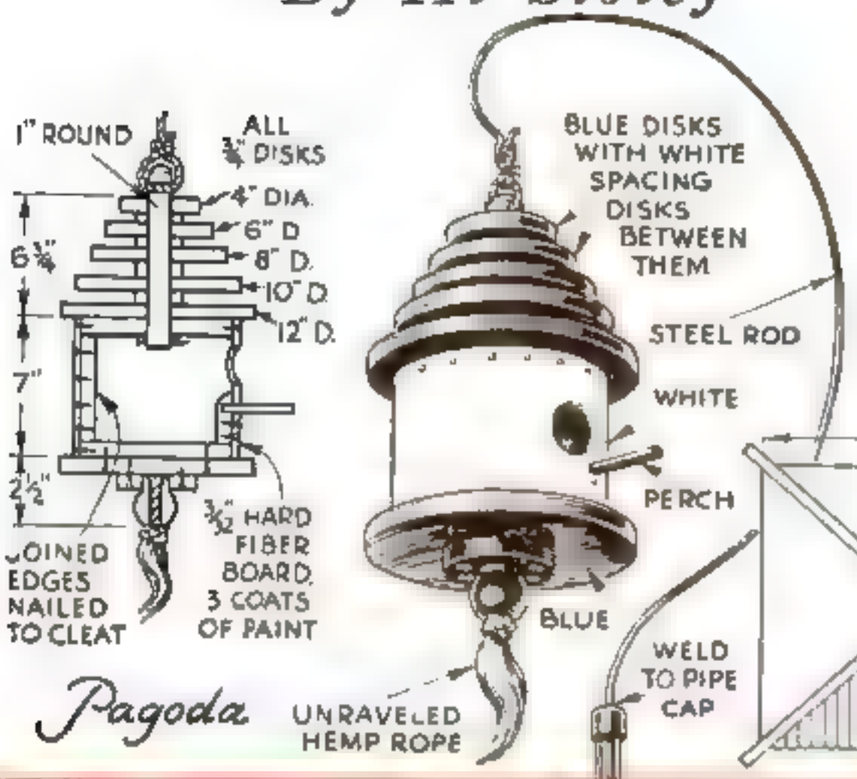
A plane can sometimes be used for producing a smooth-finished surface on hardwood, but usually it tears the grain, and scraping is necessary. For this purpose a scraper plane is indispensable and much superior to the usual hand scraper since the scraper plane leaves a true, flat surface. The blade (Continued on page 89)

The photograph at right shows the perfection with which dovetailed joints may be made by Mr. Keysor's methods. Complete working drawings are given at left and on the facing page

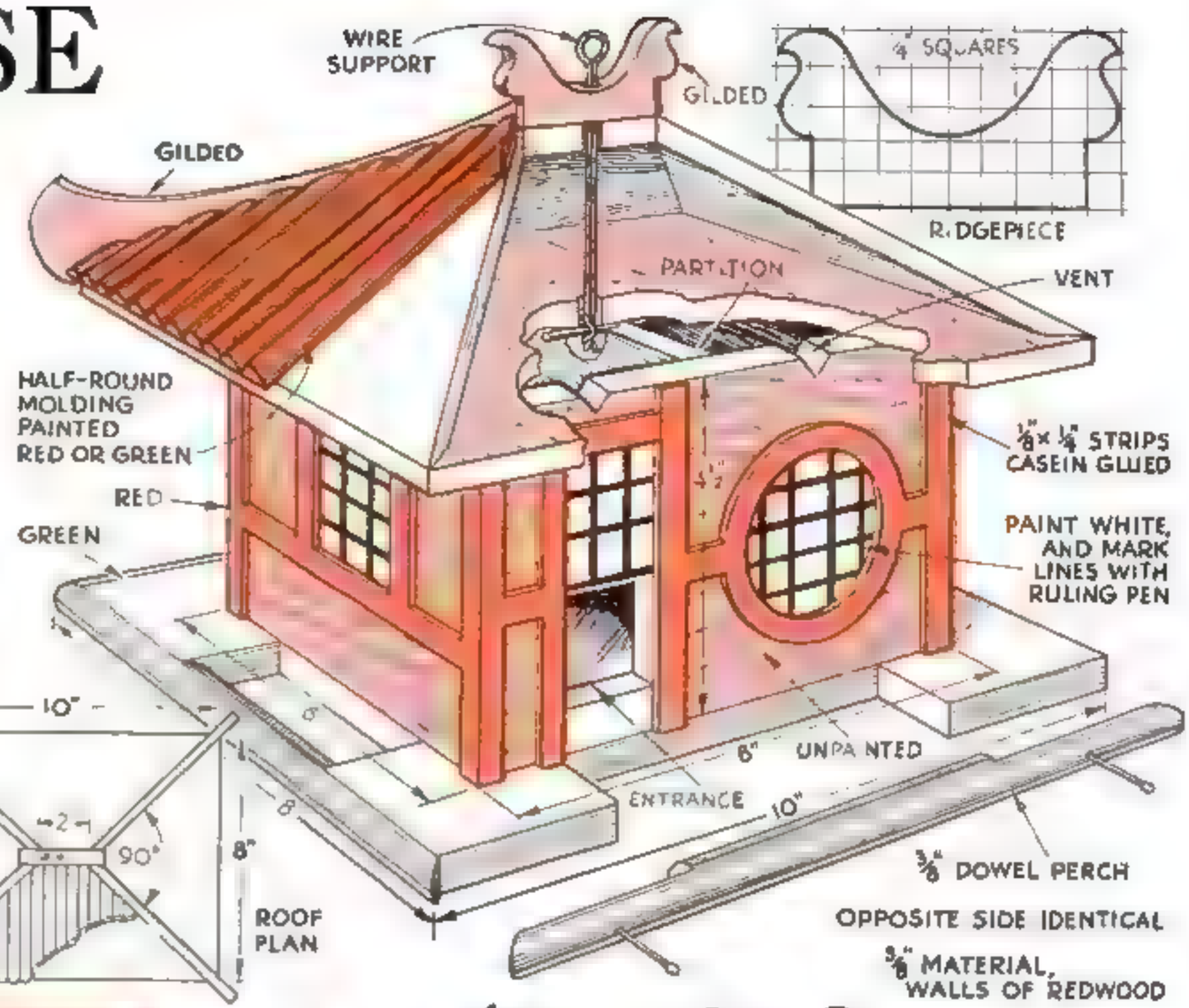


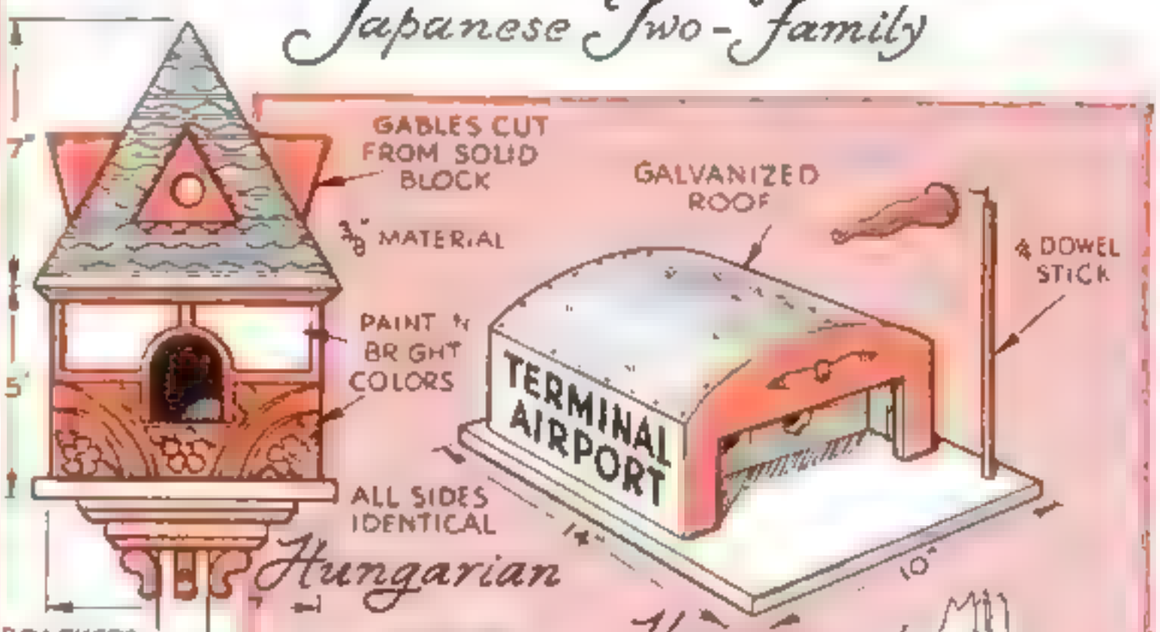
Bird-House Building

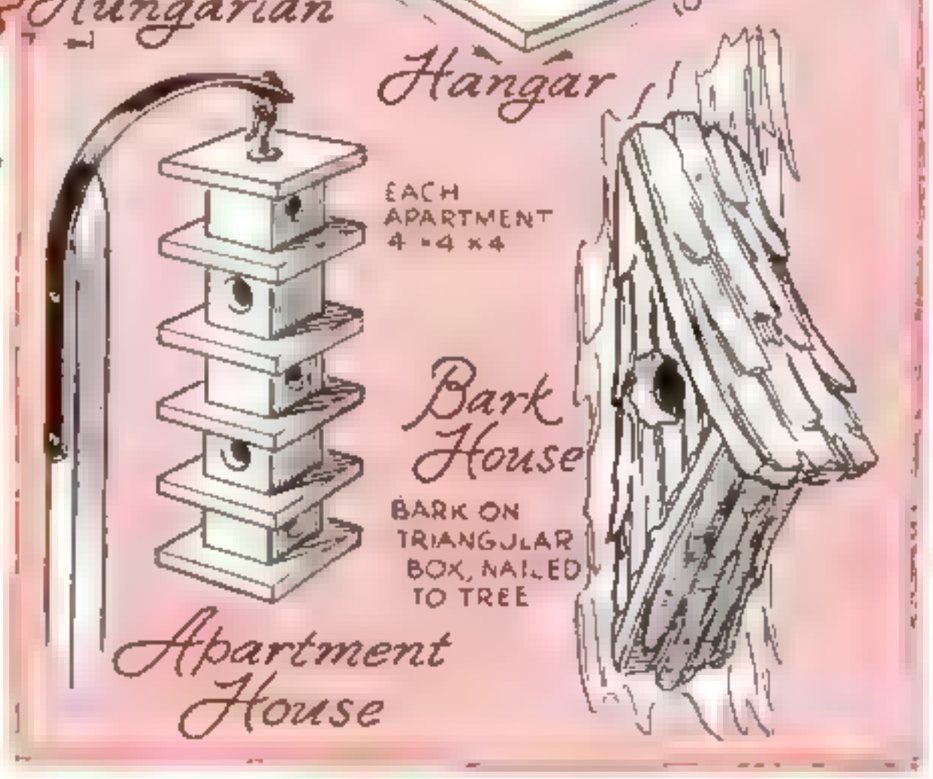
By Hi Sibley

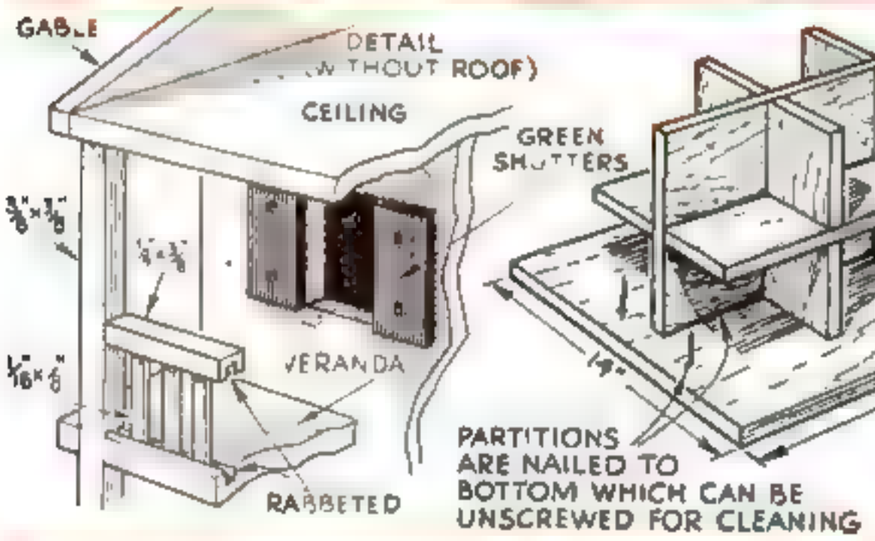


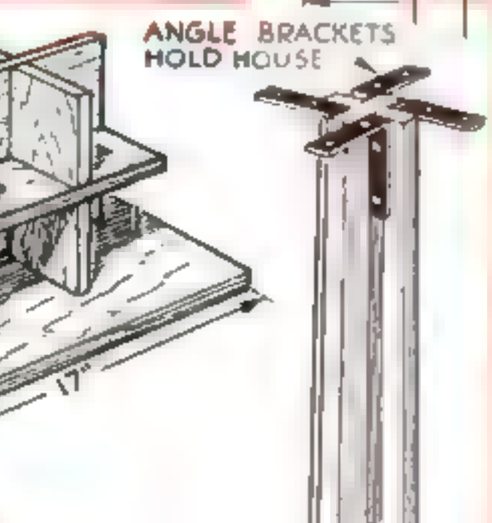
Pagoda

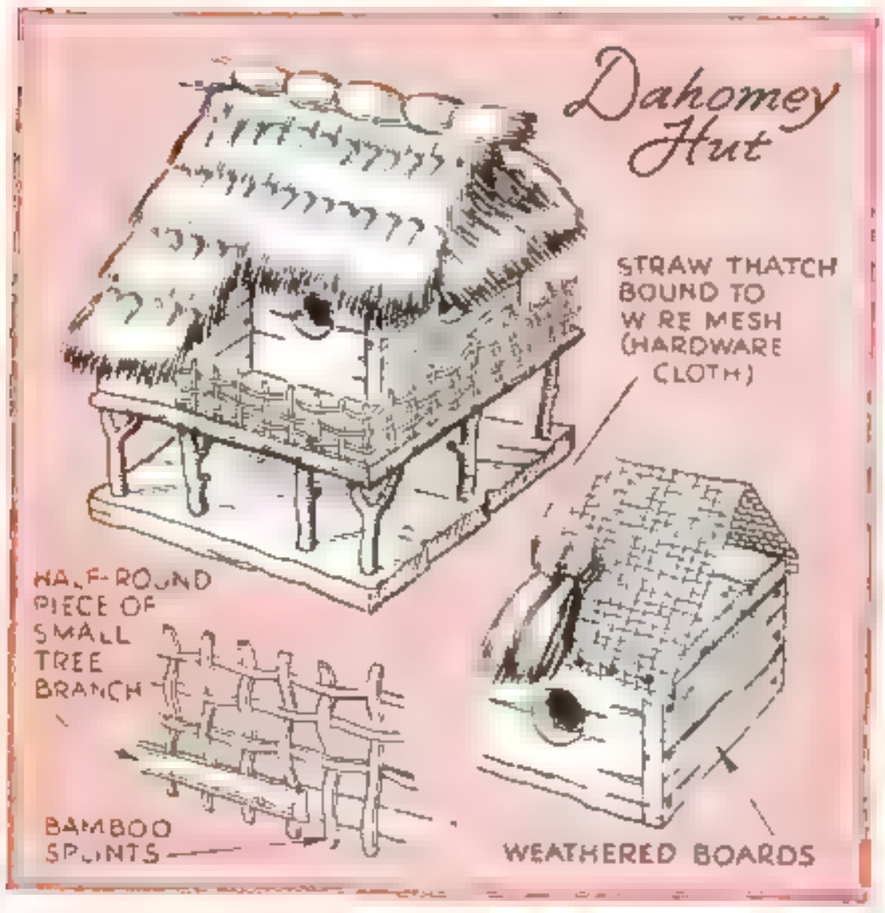












Decorative bird houses add to the attractiveness of any garden. Here are many novel suggestions. A table of dimensions is given on page 105

FAVORS FORMED FROM NUTS AND PIPE CLEANERS

The nuts are dowled together where necessary and fastened to the base with a wood skewer. Pipe cleaners, white or dyed, are freely used because it is so easy to bend or twist them into shape

Legs, tail, and comb of this fun-provoking novelty are pipe cleaners, and the bill is a pointed skewer

WITH a few black walnuts and some pipe cleaners, you can make a variety of comical novelties for use as favors and gifts. The laughable expressions on the "faces" of these strange birds and animals make them interesting to adults as well as children.

Scrub the walnuts with soap and water, then dry and varnish them. Dip some of the white pipe cleaners in Easter egg dyes, and after they are dry make them fluffy by rubbing with a stiff brush. The bases are of varnished plywood, and wood skewers are used as dowels for fastening the parts together where necessary.

When a flat, fuzzy effect is desired, pieces of pipe cleaner may be wound into flat coils and held in place with rubber bands until the glue dries. In most cases, however, holes are drilled or slots cut so that the pipe cleaners may be glued in place. The eyes are ornamental tacks, painted white and with black pupils.

A basket for miniature Easter eggs may be made from a white pipe cleaner and filled with small colored candy pills, a dab of glue being applied to each.

Birds such as cockatoos may be mounted on bits of natural twigs, and the base in this case may be a slice cut from a larger limb. For the body, use a small pine cone supported by brads, which are painted to represent the feet. The head may be shaped from a crack filler and painted. The crest and tail may be represented by cardboard stiffened with a coat of glue and then finished with varnish.—OLIVER BANDELIER.

SMALL SPOTLIGHT FOR PHOTOGRAPHERS

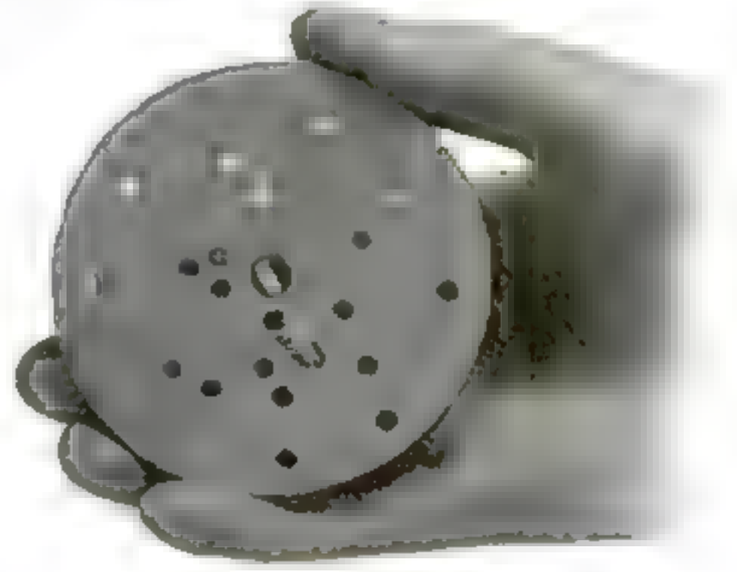
A SMALL spotlight for photographic purposes can easily be made in such a way that it may be attached, when required, to any photoflood reflector.

A disk of tin should be cut to fit the reflector. The one illustrated is 10 in. in diameter. Three ears are soldered to the edge and bent to snap over the rim of the reflector. Have the fit somewhat loose so that the heat may escape.

A hole 2 in. in diameter is cut in the circular piece, and a tin tube 2 in. in diameter and 4 in. long is soldered on as shown. Another tin tube, a sliding fit over the first one and also 4 in. long, is made for holding the lens.

The lens used in this spotlight is known as a "plus eight, uncut," and can be obtained reasonably at any optical store. A frosted glass disk 2 in. in diameter would give a more evenly diffused spotlight if fitted behind the lens. A condensing lens could be purchased, if preferred, provided the size of the tubes was changed to suit. To hold the lens, a wire is soldered around the inside of the tube ¼ in. from the end. The lens is placed against the wire ring and held by four tin clips ⅛ by ⅜ in. soldered to the rim.—W. EDWARD WHITE, Opt. D.

The parts of the spotlight attachment and, at right, how it is used with a photoflood



RING-AND-DISK PUZZLE EASILY CONSTRUCTED

THE object of the easily made puzzle illustrated above is to get the split metal ring off the wood disk. After trying for a time, most people find that they have worked the ring right back to the center where it started from, unless they are either unusually lucky or very systematic.

The disk is 3¼ in. in diameter and cut from cigar-box wood, then varnished. Drill a hole near the edge and fit the ring into it; then by turning the ring halfway around, you can locate the spot for the next hole. Continue drilling and marking holes in this way around the disk until the ring is finally led to the larger hole in the center.

Now go back and begin working it outward again and make other holes that lead nowhere, to mislead the puzzle fan. In this way the puzzle can be made as easy or as difficult to solve as may be desired.—GEORGE S. GREENE.

Sensitive Electric Eye

Magical little device will operate a photographic exposure meter or automatic garage-door opener . . . It will guard rooms, turn on lights, and do many stunts

Fig. 1. The disk is heated to red-hot for several minutes and cooled on a cold metal surface. The thin layer of black cupric oxide is removed with steel wool as at right

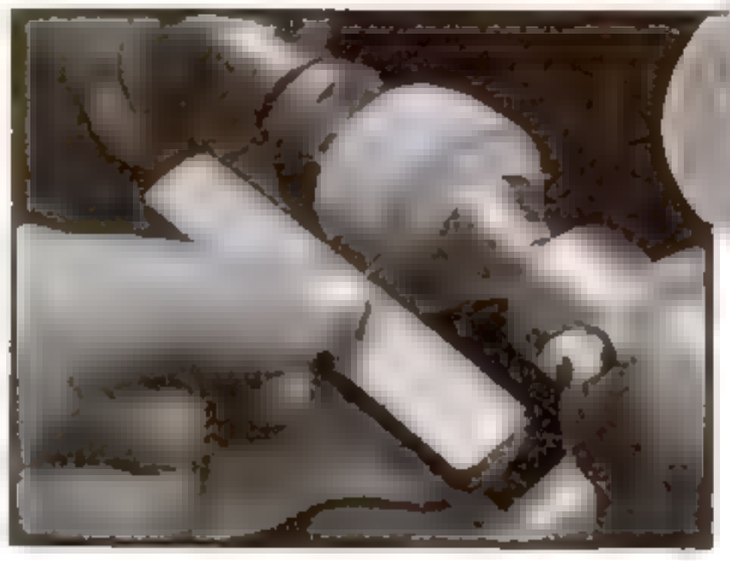


Fig. 2. A spiral of silver-plated wire may be used as a connecting grid on the red oxide

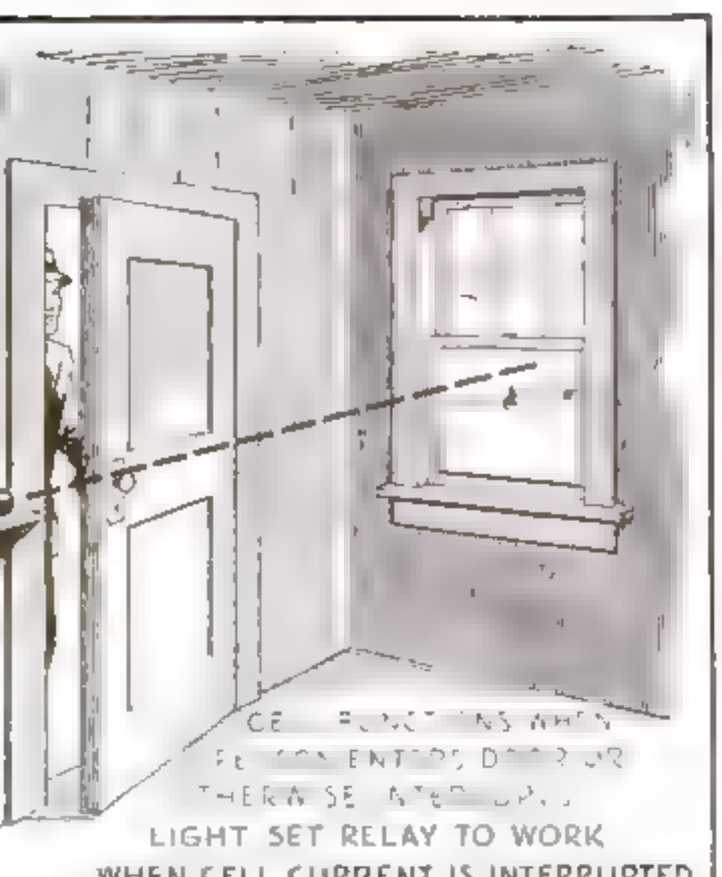


Fig. 3. An easy way to form the spiral grid is to wind the wire on a wooden cone as shown at left

WORKMEN passing between the sun and a bank of copper oxide rectifier disks were responsible, a few years ago, for the discovery of a new type photocell or the so-called "electric eye." It was found that light falling on a disk of copper covered with cuprous oxide was converted directly into an electric current.

After a great many experiments the new electronic dry disk cell has been improved until it is now used for measuring room light in tests to prevent eye strain, for photographic exposure meters that function automatically, and for various counting operations in manufacturing plants. One inventor even went so far as to connect a sufficient number of the cells to supply enough power to run a small electric motor for demonstration purposes.

The electronic cell requires no outside current for operation and there are no liquids to spill or glass bulbs to break. One of the cells can be housed in a casing the size of a pocket watch, and carried as easily.

The manufactured cells of this type will give a current of over 5 milliamperes in daylight. The efficiency of a homemade cell depends on the care with which it is constructed, but is sufficient to operate a sensitive relay. It can be used for turning on the lights in a room when it becomes dark outside, opening garage doors, ringing bells when a beam of light is interrupted and other practical applications. For measuring light it is connected directly to a sensitive meter, such as a direct-current milliammeter or microammeter, and a special dial is calibrated for the purpose.

By Kenneth Murray

For making the disks, you will need pure sheet copper, 1/32 in. thick. The strength of the current depends on the size; the disk illustrated has a diameter of 2¼ in., but smaller sizes can be used satisfactorily. Leave a lip on the edge so that it can be grasped with pliers (Fig. 1). Dip the disk in water, flow it with nitric acid until the surface is absolutely clean, then rinse in water and dry with a clean cloth. It is important that the disk be perfectly clean.

Cuprous (copper) oxide is formed on the disk by subjecting it to a red heat for several minutes over a Bunsen burner, as shown in Fig. 1. Move it about so that all parts will be evenly heated, then lay it on a cold metal surface (such as a heavy steel saw table) to cool. The outer surface will be covered with a thin layer of black cupric oxide, which will loosen itself from the surface by this cooling method and can be readily brushed off with fine steel wool.

Be very careful not to remove the layer of red material, which is the photoactive cuprous oxide and lies immediately under the black oxide film. If the red oxide becomes scratched or worn through to the copper underneath, the disk must be cleaned and reheated, otherwise it would short-circuit the finished cell and a current would not be produced. Usually the extreme edge of the disk will lack the red oxide coating, so the coat of silver or the wire grid, which is to be applied next, is not allowed to reach the edge.

Held in the light, the cell will now generate a current between the oxide and the copper, the latter being positive and the oxide negative. So that the current may be usable, connections must be made. The

Made *from a* Copper Disk

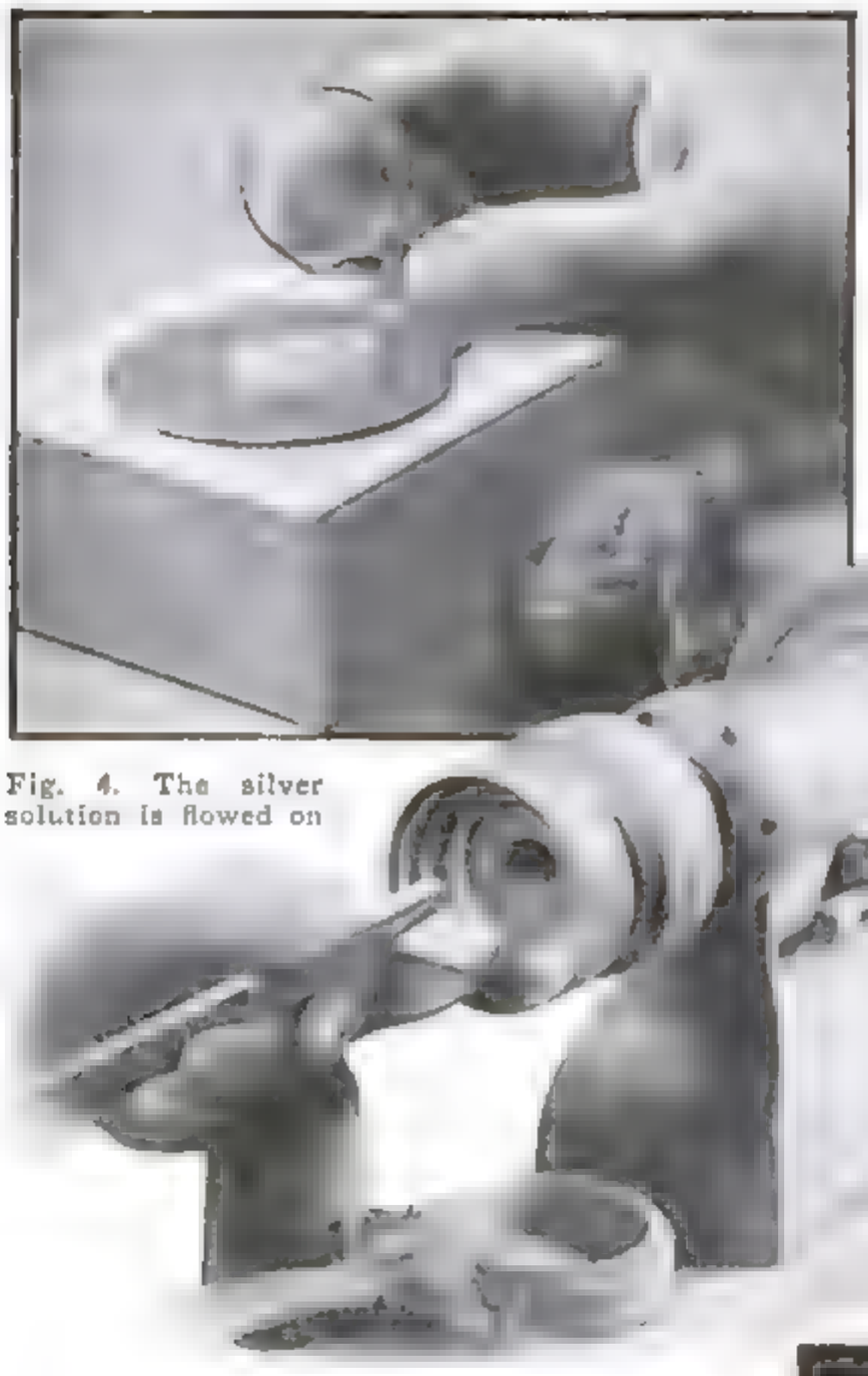


Fig. 4. The silver solution is flowed on

Fig. 5. That half of the wooden box for housing the photometer must be turned in a series of steps. A full-size drawing is given below

back of the disk can be cleaned with emery paper for one connection. To lower the resistance on the face side, however, the surface of the oxide must be partly covered over with a grid, which can be a coil of silver-plated wire or a coating of pure silver.

THE wire grid is less efficient, but easier to apply. Use 30-gauge wire, forming it into a spiral to cover the oxide (Fig. 2) and holding it in tight contact by means of a cover glass. Allow one end to project from under the glass for making a connection, but see that it does not touch bare copper. A good way to make the grid is to wind the wire on a wood cone, as shown in Fig. 3.

Coating the oxide with a thin, transparent film of silver is a more delicate operation, but gives more satisfactory operation. It is done chemically by pouring a special silvering solution over the oxide, allowing the silver to precipitate, and then gently washing and drying. Level the disk when flowing with the solution, so that the latter will form a circular pool as in Fig. 4.

Use distilled water for the solution. Make up ten percent solutions of ammonia, caustic potash, and Rochelle salt. In 1 oz. water dissolve a crystal of silver nitrate the size of a safety-match head, and add drops of ammonia solution until it becomes almost clear after first turning brown. Add a drop of the potash solution, then more ammonia until it is almost clear again. The solution should be slightly cloudy; if too much ammonia is used, it will dissolve away the cuprous oxide on the disk. Stir in one drop of the Rochelle salt solution and use immediately.

The film of silver should be very thin, and when gently polished the disk should have a silvery color with the red oxide slightly showing through. Contact is made to this surface with a metal ring (silver-plated copper, or lead) of slightly less diameter than the disk. It is advisable to give both the contact ring and the face of the disk a coat of thin lacquer, but do not allow the lacquer to come between the ring and the silvered surface and spoil the contact. The cell is housed in a turned wood box made as shown in Fig. 5.

In using the cell as a photometer, the sensitive meter and the electronic disk are housed in the same container, as shown in the drawing of the group of illustrations marked Fig. 6. The half of the box holding the cell is turned in steps, as in Fig. 5, in order that the disk may be set back from a light opening of smaller diameter. This is to limit the light entering the box so that only the light reflected from the scene to be photographed can affect the cell. One of the illustrations shows how an opening is cut in the other half of the box for the meter scale; hold the box on the saw table with the hands, and with the regular hold-down out of the way. Both the front of the photometer and the meter side are shown in Fig. 6.

A SPECIALLY calibrated scale must be attached over the regular meter scale. It can be accurately calibrated from an outdoor scene requiring a known exposure, such as 1/25 second at F/16. Train the cell side of the meter on such a scene, making a pencil mark on the scale where the pointer rests and marking it "16." Then take the meter indoors and train it on a large sheet of white cardboard illuminated with a photoflood lamp in a reflector. Move the lamp nearer or farther away from the cardboard, until the reflected light causes the meter pointer to rest at the pencil mark. By folding the cardboard in half, half as much light will be reflected and the pointer will rest at the next larger stop position. By using twice as much cardboard, the next smaller stop position will be indicated. In this way, pointer positions for each stop at 1/25 second can readily be found and marked on the scale. Stops for other speeds can be figured easily enough once the correct stop for 1/25 second is known.

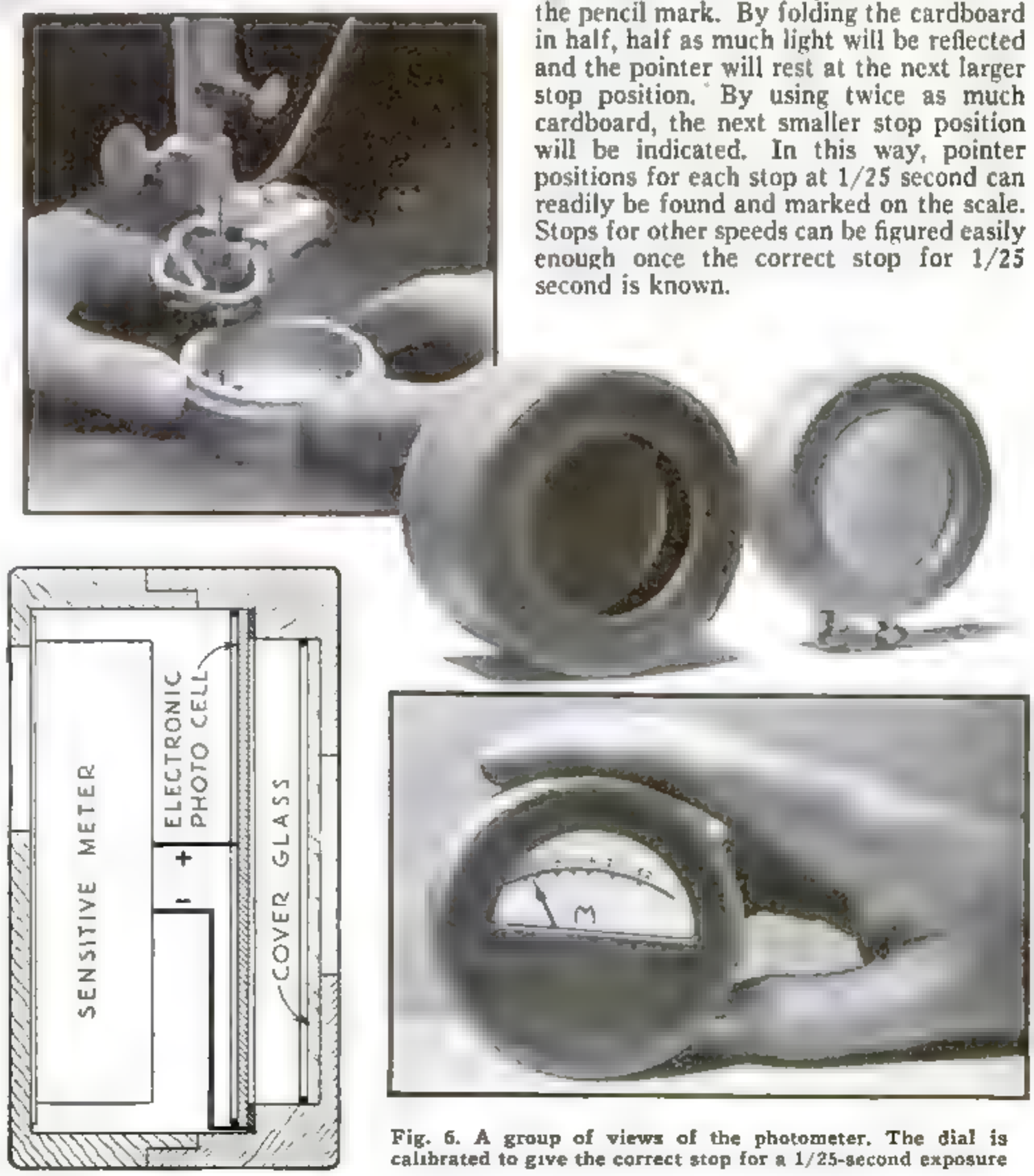


Fig. 6. A group of views of the photometer. The dial is calibrated to give the correct stop for a 1/25-second exposure

FOR information about our blueprints, turn to page 82.

HINTS ON ASSEMBLING

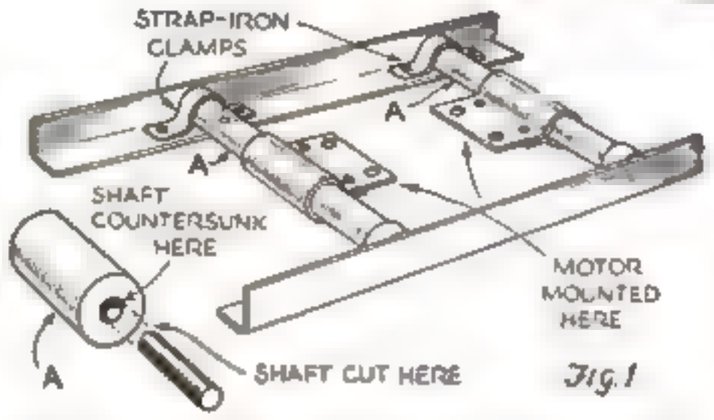
SOAP-BOX RACERS *and* Midget Autos

By BIL GREDICK

Bil Gredick in one of his midget autos. He hails from Akron, Ohio, where the greatest of soap-box races is held

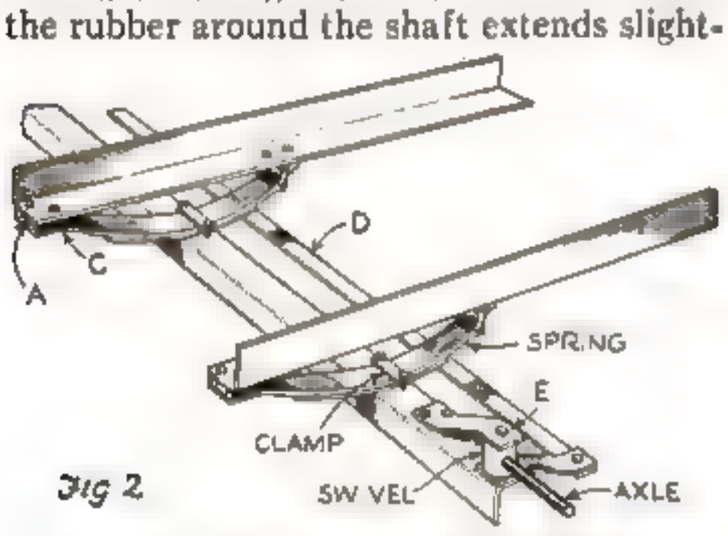
THOUSANDS of boys are getting ready to build new midget cars in the hope of entering the soap-box racing events that will be held in many cities and towns this summer. Others, who are too old for this type of contest and have progressed beyond plain coasters, are interested in constructing miniature automobiles that have their own power plants, usually a one-cylinder motor. To aid both these classes of midget auto builders in designing simple yet strong and durable cars, the accompanying sketches have been prepared. They embody ideas successfully worked out by a schoolboy.

The motor mounting shown in Fig. 1 is suitable for small, single cylinder motors, which have a greater tendency to vibrate than multicylinder motors. This mounting eliminates the greater part of the vibration. Parts *A* are wringer rollers from a discarded washing machine. The projecting shafts are cut off even with the rubber; the ends are then countersunk with a drill larger than the shaft so that the rubber around the shaft extends slightly over it. The rollers are fastened to the frame with strap-iron clamps. When a motor is mounted on rubber, the gas and oil lines must be made of flexible tubing or a rubber hose that is designed to hold fuel.



How old wringer rollers are used to reduce vibration when mounting a one-cylinder motor

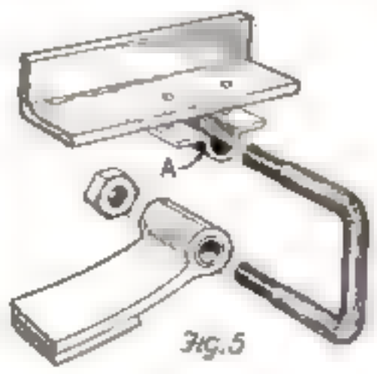
The front end illustrated in Fig. 2 is substantial enough for any type of midget car. The springs are from a model-T Ford. One type of homemade U-bolt joint is detailed in Fig. 5, another in Fig. 8. The latter is taken, like the springs, from a model-T Ford and has the advantage of being already bushed and provided with means for lubrication. The end of the spring, opposite the U-joint, is heated over the fire in a stove or furnace and is then easily bent in a vise. A rubber pad made from an inner tube is placed at *A*, Fig. 2, to relieve the strain on the bent joint *C*. In Fig. 8, however, is shown a more workmanlike way to cut and bend the front ends of the frame to match the angle of the springs.



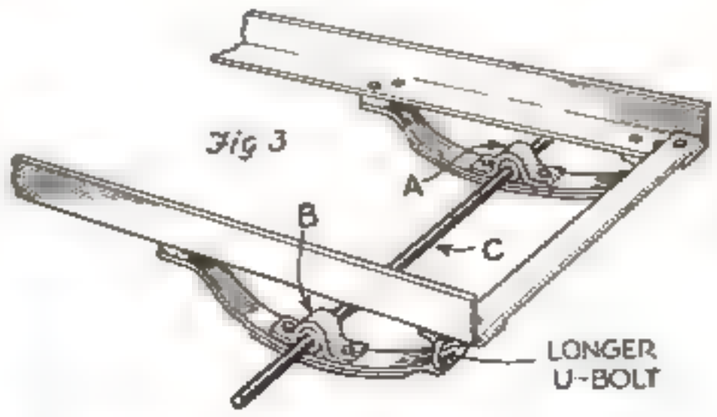
A front end of sturdy design with springs from a model-T Ford (compare with Fig. 8)

The frame axle, made from angle iron, is clamped under the double springs as shown. The swivels at each end of the axle are cut from a solid round piece of iron. A hole is drilled in the center for the kingbolt. The lead or connection from the swivel to the radius rod is bent out and down to keep the radius rod *D* away from the springs. The lead is welded to the bottom of the swivel. The wheel axle is made to fit the wheel bearings and may be designed to screw into the swivel or it may be welded on, but care must be taken that the axle is at right angles to the kingbolt. The brace *E*, steadying the kingbolt, is cut from a strip of iron and bent to the shape shown.

Figure 3 is a sturdy rear end assembly. It is constructed the same as the front end in Fig. 2, except that the U-bolts are longer to give ample space for springing between the bearings and the frame. The bearings are from the rear end of an old automobile. They are clamped as shown through the double springs on each side. The stationary part of the bearing may be spot welded to the clamps *A* and *B*, and the rotary part welded to the axle *C*. If the clamps *A* and *B* are made to fit snugly around the bearings, it is not necessary to have them welded to the bearing. The bearing is lubricated by wrapping felt around it and keeping the felt saturated with oil. This will also prevent dirt and grit from entering.

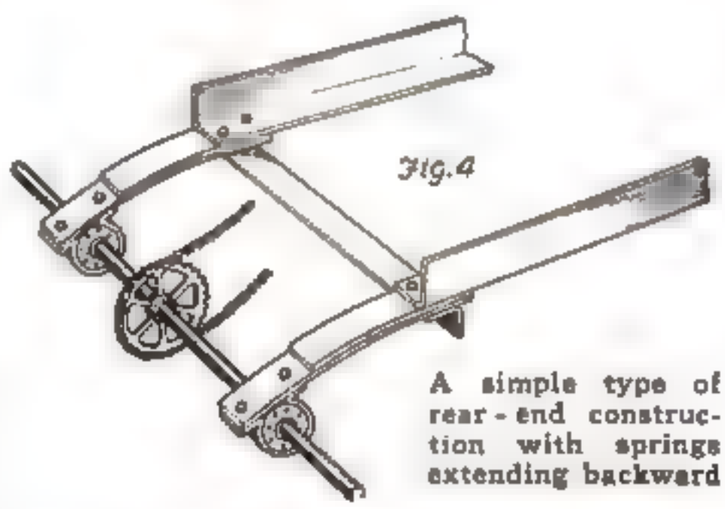


An improvised method of fastening springs to the frame. Some work may be saved if a special fitting can be obtained like that illustrated in Fig. 8



A substantial rear-end assembly. The bearings are from the rear end of an old auto

Another type of rear-end construction, somewhat simpler than Fig. 3, is shown in Fig. 4. The springs are fastened to the frame, and the bearings are bolted at their outer ends. The bearing design is similar to the one in Fig. 3. The distance from the end of the frame to the axle should not exceed 12 in., as the springs must not be too long. Due to the arrangement of the springs, the distance from the axle to the drive unit will tend to lengthen a bit, so if a chain is used for the drive, it must be loose enough to permit the springs to work freely. However, this lengthening and tightening of the chain will not affect the operation of the chain and sprocket if they are in line. These bearings are lubricated like those in Fig. 3.



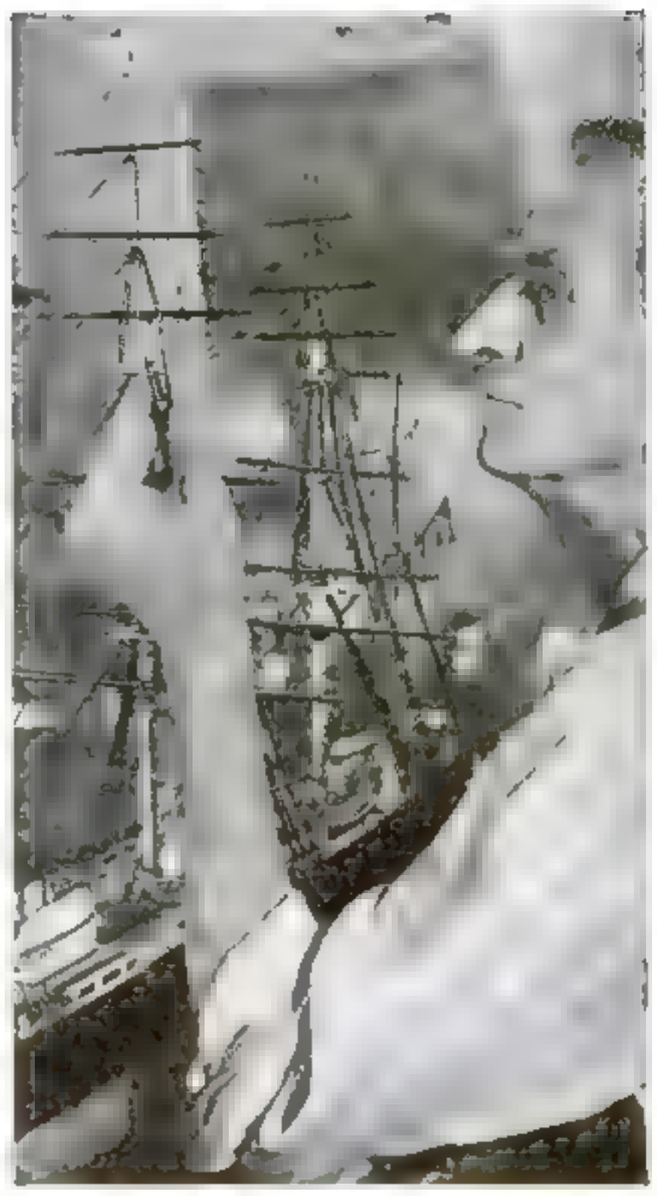
A simple type of rear-end construction with springs extending backward

For making a typical U-bolt joint as in Fig. 5, the springs and U-bolt are taken from an old car, preferably a model-T Ford. The clamp *A* is made from a piece of iron and holds the U-bolt in position on the bottom of the frame. The U-bolt is held in the spring and clamp by means of the nuts that come with it. Be sure the clamp holds the U-bolt parallel with the hole in the spring.

It is possible to make a good front end as in Fig. 6. The springs are attached as are the springs *(Continued on page 98)*

Installing the RIGGING on Our New Model of the

GREAT REPUBLIC



Captain McCann's models are noteworthy for their shipshape rigging. Here he is adjusting a line on the *Great Republic*

ONCE the spars are made as described in last month's issue, we are all ready to begin rigging our model of America's largest clipper ship, the *Great Republic*. She was heavily rigged. Her lower shrouds, for example, were of rope 12½ in. in circumference; her topmast shrouds, 8 in., and other gear in proportion. To represent the 12½-in. rope on our scale of 3/32 in. to the foot, cord 1/32 in. diameter is required. The 8-in. size will be two thirds of that, and so on down to the skysail braces, for which we can use line equal to No. 70 mercerized sewing cotton.

As many sizes of cord as desired may be used, but not less than four, the rule naturally being that the higher the spar, the smaller it is and the lighter its gear. I used five sizes, the largest being 18-thread linen fishline.

Very little Manila hemp was used in 1853, so the running gear (which reeves through blocks) should be stained brown to represent tarred Russian hemp (which sailors call "Europe"). The standing rigging, deadeyes, and lanyards will be black. The sizes of cord, blocks, and so on were given last month on page 94.

The bowsprit is stepped, and the gammoning lashing, of fine bead chain, is passed; it goes over the 'sprit and through the hole in the forefoot. The turns cross and are frapped together under the 'sprit.

The bobstay and shrouds are chain, drawn tight with hearts and lanyards.

The foremast, mainmast, and mizzenmast are alike except for size, so we shall describe only the rigging of the foremast. It is stepped accurately upright, but with the correct rake. I line my masts by truing up the hull with a spirit level and sighting the masts against a window frame.

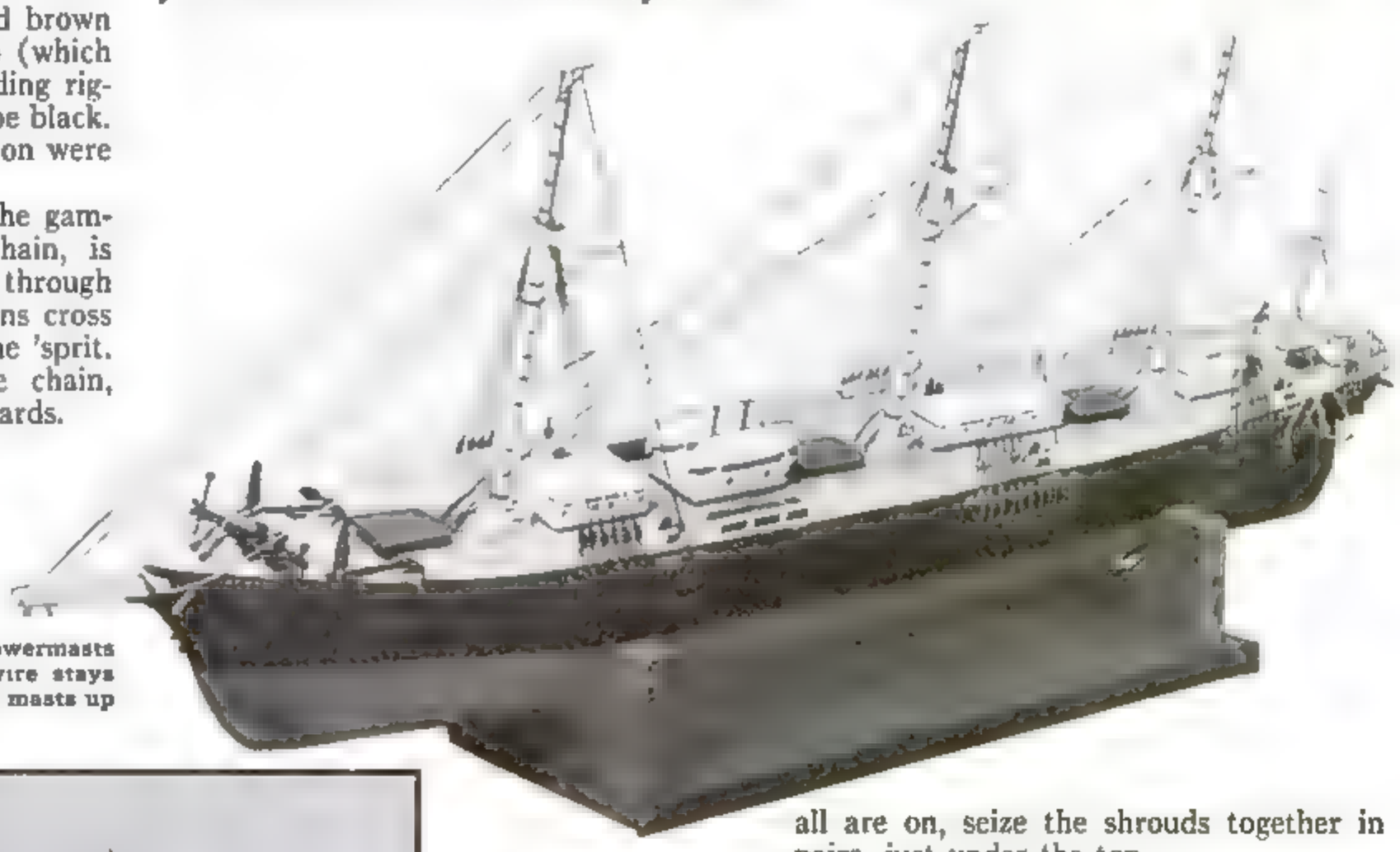
First to go on are the starboard, forward pair of shrouds, then the port pair, and so on, working aft, until there are three pairs to a side. Reeve the cord up through the lubber hole, around the lowermast, from aft forward and down again. Seize in a deadeye and reeve off a lanyard so that the knot in the end will be opposite the left eye when looking outboard. I use fine copper wire from flexible electric lamp cord for the seizings, of which I make two about ⅛ in. apart. Thread is as good, although a little more trouble to use. The ends of the shrouds turn up forward on the starboard side and aft on the port.

Draw down the deadeye to come nearly to the handrail. Stretch the other end of the shroud down and turn in another deadeye; reeve the lanyard and draw both down very tightly until the lower edges of the deadeyes will just clear the handrail. Secure the lanyards with hitches above the deadeyes. When all are on, seize the shrouds together in pairs, just under the top.

Immediately along the tops of the deadeyes, seize a piece of stiff wire to form the sheer pole. It can be seized in position with fine thread and a needle, a turn being taken through the bights of the shrouds so that the deadeyes cannot turn.

The ratlines (steps) are either size A sewing silk or size 70 to 100 thread. They are clove-hitched horizontally to each shroud. I use a bent needle for this, working from left to right. They must be the same distance apart (about 3/32 in.) wherever put on, and straight, but not so tight as to drag the shrouds together. They extend up the futtock shrouds and later to the topgallant masthead.

Take the forestay from its forward position around the mast, turn in a heart on each end *(Continued on page 103)*



The model is shown at right with lowermasts and rigging up. Note temporary wire stays at the mizzenmast. *Below:* With all masts up

PART IV
OF A SERIES
OF ARTICLES
ON A FAMOUS
AMERICAN
CLIPPER
SHIP

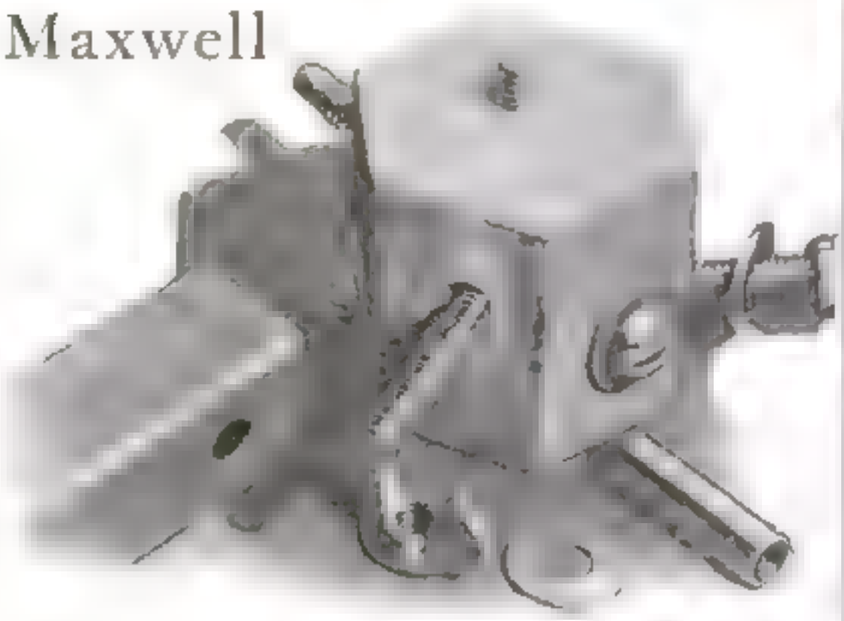
By Capt.
E. Armitage
McCann

HERE'S A HOMEMADE

Camera Tripod

that never slips, sways, or skids

By Alexander Maxwell



So rigid is the tripod that it can be lifted by one leg and carried from place to place without disturbing its adjustment. The head is shown above

ONE of the old comedy stand-bys is the photographer whose tripod collapses just as he is taking a picture. It is funny to the audience, but no laughing matter to the serious picture taker. Any one who has attempted to set up a tripod on a tin roof or a polished ballroom floor knows just how exasperating a task it is.

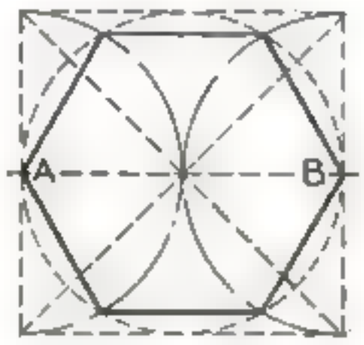
There are, of course, various devices on the market for steadying tripods, but the homemade tripod illustrated is designed so that the bracing is an integral part of the tripod itself. It requires less material than a standard wooden one of identical size, contains fewer parts, weighs considerably less, and still sacrifices nothing in strength or rigidity. On the contrary, it is more adaptable to the "grab and run" tactics needed at ball games, athletic contests, and in crowded places. The entire tripod, camera and all, may be held over the head with one hand, while the photographer mills through the crowd, carrying his flash gun and kit in the other hand.

The design goes back to fundamental principles. First, the axis of the legs was changed from radial to tangential so that any tendency to slip must be transferred through an angle of ninety degrees to become effective. Second, clutch plates were incorporated in the hip joints of the legs. When tightened, they grip like a bulldog.

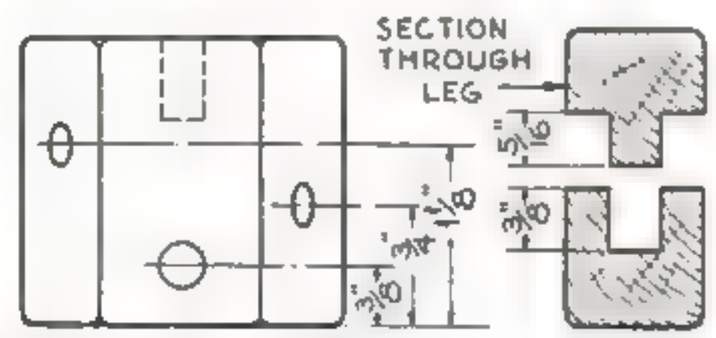
Third, the legs telescope on tongue-and-groove ways. No matter how far or how little they are extended, there is no side sway or tendency to be weak in the knees.

The tripod is ideal for home movie work, because waxed floors, gable roofs, and heaving decks are all one to it. When once set up, it stays put, and the photographer can concentrate on his picture.

Accurate construction is essential if the tripod is to be a success. A circular saw will save much work, and a drill press also comes in handy. However, a fine tripod may be turned out with only hand tools, if proper pains and plenty of patience are employed.



The tripod head is a block of hard maple 1¾ by 2 by 2 in., cut to a hexagonal shape. The legs are made of 1-in. square mahogany and are tongued and grooved at the joints



One of the assembled leg joints is shown in the photo at the right

The maple block (see the list of materials near the end of this article) must be cut into a hexagon. There are various ways to lay out a hexagon within a square —in this case, a 2-in. square. One of the simplest is as shown in the diagram. Find the center by drawing diagonals, and draw line *A-B*, dividing the square in half. Then inscribe a 2-in. circle and, using the same radius, draw arcs with points *A* and *B* as centers. Where these arcs intersect the circle are the other points of the hexagon.

One of the four 1¼-in. long machine screws is to be used to hold the camera to the tripod head. The standard American thread is U.S.S. 20. If your camera is European, it may have the Continental thread, which requires a special screw. This can be obtained from the dealer who handles your make of camera.

If a tap is available, the wood can be threaded to receive the screw. To align the head, center it in the drill press and bore a 3/16-in. hole ½ in. deep. Then place the tap in the chuck and feed by hand very slowly, using considerable pressure on the press.

An alternative method is to bore a ¼-in. hole, smear the threads of the screw with a wood plastic compound, and drive it in place. The composition will harden overnight and be almost as solid as if the wood itself were threaded. If the screw protrudes too far, file off the end.

Bore ¼-in. holes in each face as indicated on the diagram, staggering them sufficiently so that they do not meet internally. This is the most exacting part of the entire construction. If the holes are not exactly perpendicular, the clutch plates will not bear evenly.

The longer pieces of mahogany are the upper sections of the legs. Round the corners of the upper face, and plow a groove in the lower face to receive the tongue, which is to be cut on the lower section. A dado saw will dig out this groove in a minute, and a single blade will make it in *(Continued on page 83)*

The holes at the top of the legs through which the clamping screws pass are bushed with brass tubing, ¾ in. long. To avoid damaging the wood, the bushings are pressed gently into place with a C-clamp

268 Cash Awards for PICTURES AT NIGHT

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A $250 Grand Award will be given to one of the six winners of the $100 award; hence, the grand award winner receives $350 for a single picture.

RULES

1 Any number of pictures made on or after January 1, 1936, may be entered. Entries must be postmarked not later than midnight of February 15, March 15, and April 15—the three closing dates. Contests are open to any amateur in the United States and Canada (except employees of Eastman Kodak Company and those engaged in the manufacture or sale of photo supplies).

2 Prizes will be awarded *only* for pictures made at night, either indoors or outdoors, by artificial light. Winners will be chosen solely on subject interest and appeal, not on technical excellence. The decision of the judges shall be final.

3 Each prize-winning picture with negative and sole rights for advertising, publication, and exhibition in any manner shall become the property of the Eastman Kodak Company. If winning picture is of a person or persons, their (or, if under 21, the parent's) written consent to use the picture must be furnished before prize can be awarded.

4 **Each print must bear, on the back, your name, address, make of camera, kind of film, and lights. No prints can be returned. Be sure to keep the negatives.**

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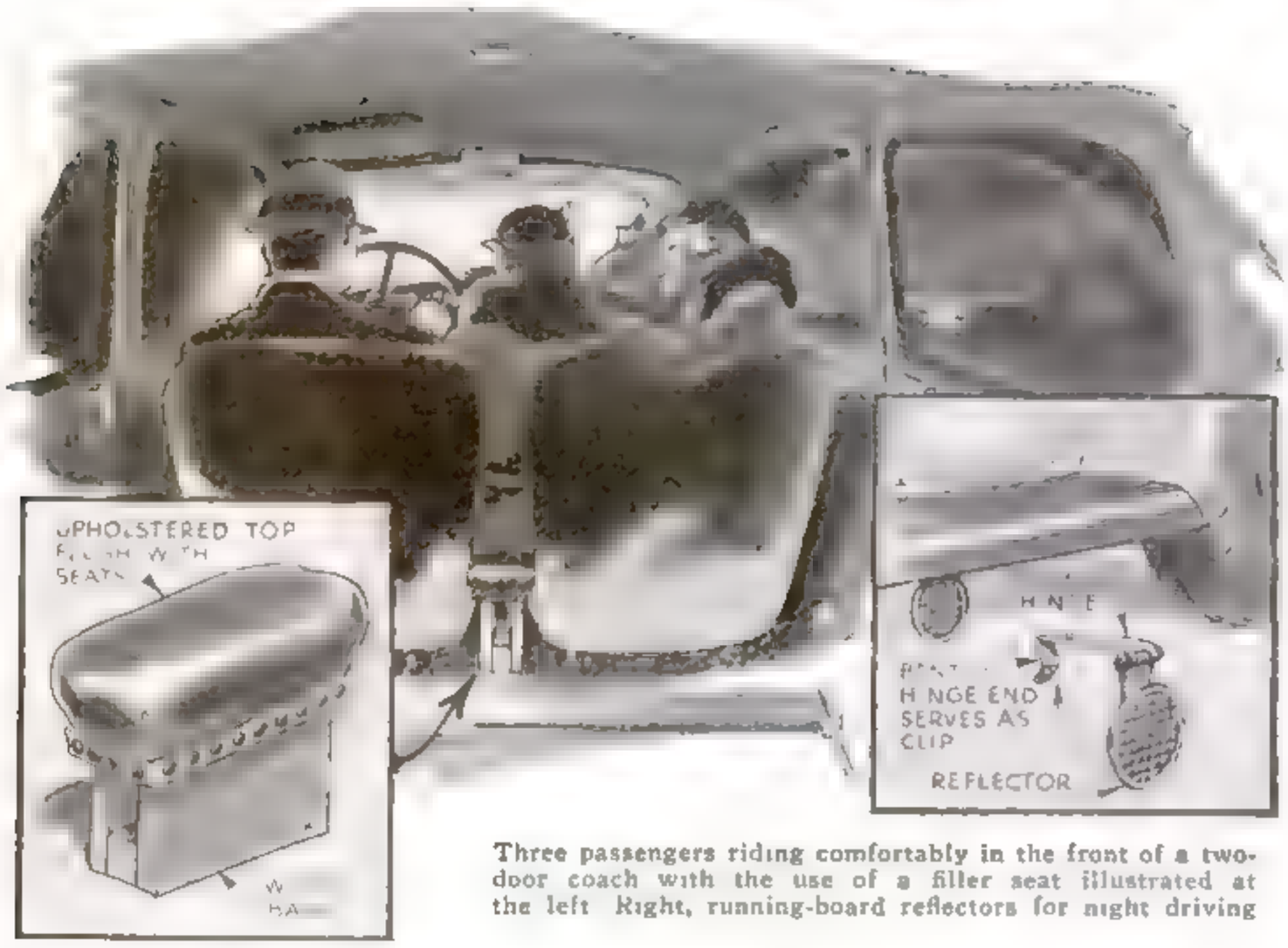
TIME-SAVING KINKS FOR CAR OWNERS

Ingenious Methods Found By Our Readers to Solve Common Motoring Problems



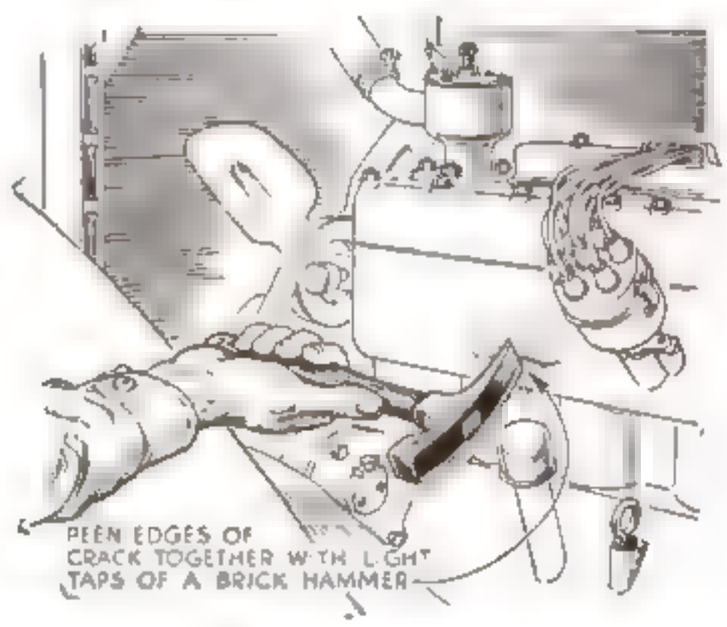
Three passengers riding comfortably in the front of a two-door coach with the use of a filler seat illustrated at the left. Right, running-board reflectors for night driving

Running-Board Reflectors

FOR night driving, the danger of side-on crashes can be reduced by fitting your car with running-board reflectors as shown in the drawing at the left. Made up by fastening an ordinary red jewel signal to a galvanized spring hinge, each reflector can be folded back under the running board when it is not in use, a hook bent in the end of the hinge serving to hold the reflector up out of the way. By reflecting light from the head lamps of cars approaching yours at right angles, the signals warn drivers who fail to see the beams from your headlights.—W. L.

Makes Two-Door Coach Seat Three in Front

THREE people can sit comfortably on the two front seats of the average two-door coach if the car owner builds the easily made filler seat illustrated above at the left. It consists simply of a rectangular wood frame or base padded and upholstered to bring its top flush with the two seats. The width and length of the frame should be arranged to make the filler seat fit snugly into the space between the two permanent seats. When this extra seat is not needed, it can be easily removed and stored under the rear seat with the tools or in the trunk, if the car is equipped with one of these storage compartments.—W. G. L.



Mending Cylinder Crack

SEVERAL winters ago, when an unexpected freeze-up cracked the cylinder block on my car, I decided to try to repair it myself. After I had run the engine to bring it up to normal temperature, I peened the edges of the crack together with the blunt end of a mason's hammer. This, of course, only served to close the outside of the crack, but several months' accumulation of rust on the inside of the block provided a good seal at the inner edges. After two years of continuous service, the repair, which was intended to be only an emergency one, is still tight and entirely effective.—C. W. C.

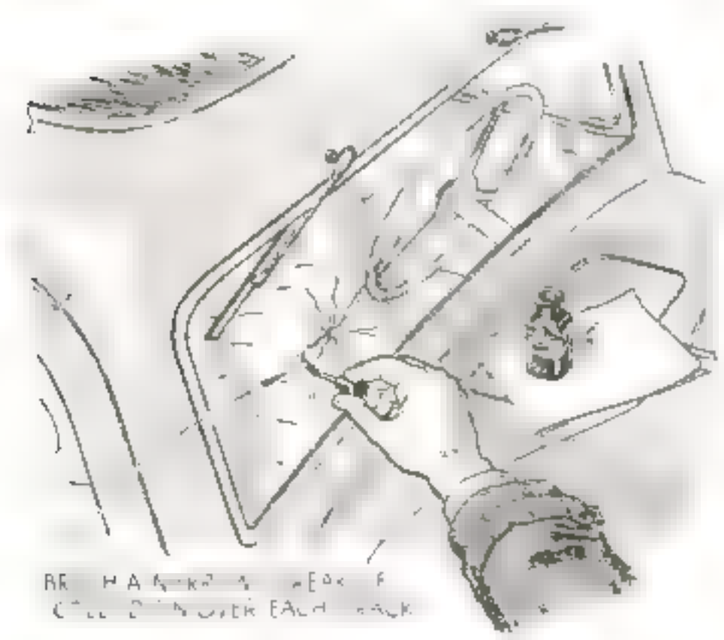
Collodion Seals Cracks In Shatterproof Glass

CRACKS in shatterproof windshields and car windows cause the glass in time to become yellow and cloudy. This is caused by the action of the air on the inner sheet of plastic material that serves as the binder (P.S.M., July '33, p. 56). On the windshield, such discoloration may interfere with the driver's view. To prevent this, apply a thin coating of collodion to all cracks as soon as they are discovered. It will seal the openings and protect the inner filler from air and moisture. Being waterproof, the collodion coating can be washed.—E. N.

Fan blade marked to show engine speed for carburetor adjustment

Fan Speed Is Gauge For Idling

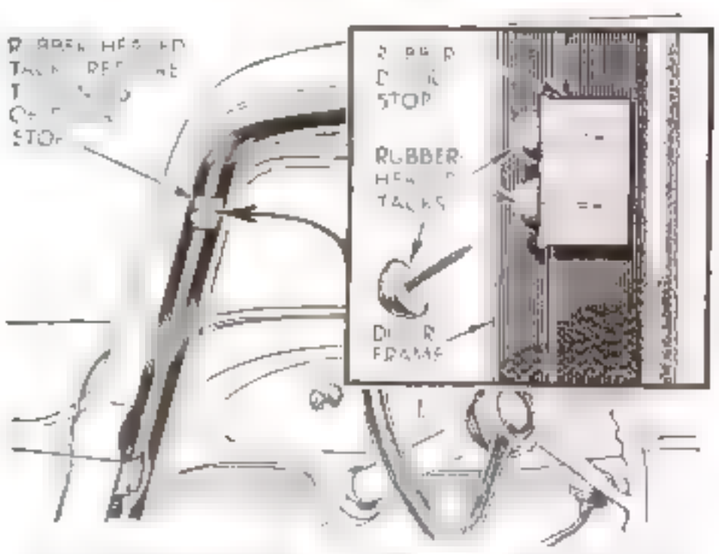
WHEN adjusting a carburetor for the best idling mixture, a much finer setting can be obtained if a piece of white paper is wrapped around one fan blade and fastened with string. By watching the white blade flash by, instead of listening to the motor, it is a simple matter to judge the speed and regulate it to eliminate a "gallop."—J. P.



Applied to cracks in shatterproof glass, collodion keeps out air and prevents discoloration

Renewing Door Blocks

AFTER a closed car has been in use for some time, the rubber door blocks often become so worn or flattened that they no longer hold the edge of the door firmly in place and the rattling of the door becomes a source of annoyance to the car owner. A neat and effective repair can be made by pressing one or two small rubber-headed tacks into the face of each cushion stop. The thickness of the rubber heads raises the buffer surface sufficiently to give a tight fit and keeps the door from rattling.—E. E. S.



Door stop with rubber-headed tacks driven in to restore thickness. Inset gives details of the job

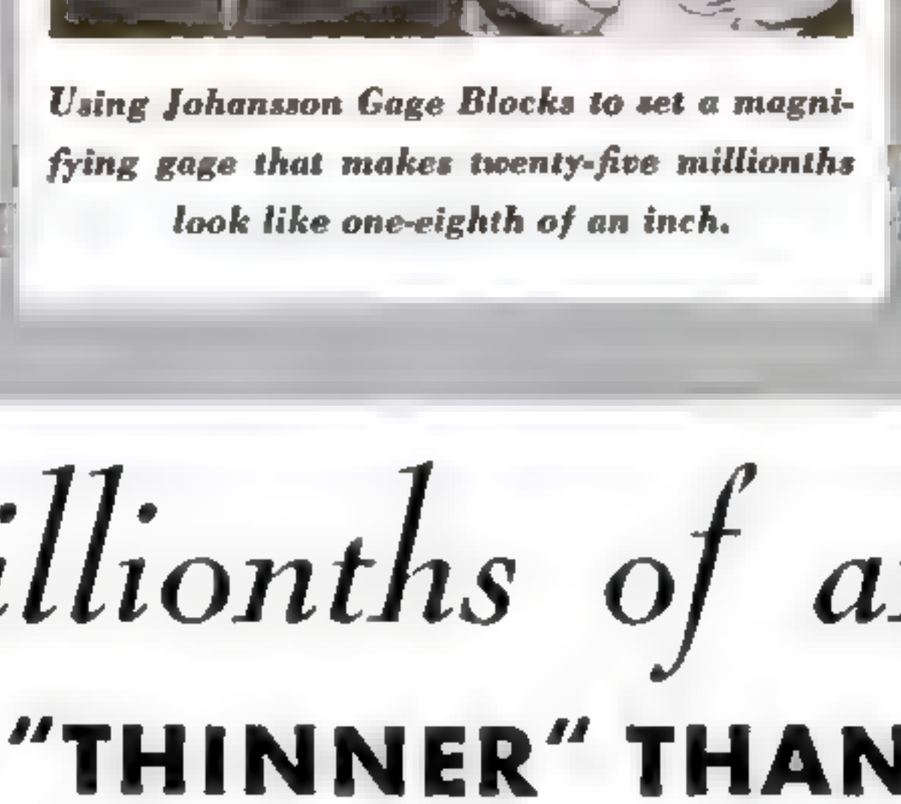
Verifying the accuracy of a "go" and "no go" snap gage.

Using Johansson Gage Blocks to set a magnifying gage that makes twenty-five millionths look like one-eighth of an inch.

Checking spacing of spline gage with a combination of 3 Johansson Gage Blocks.

Two-Millionths of an Inch—

1400 TIMES "THINNER" THAN THIS SHEET



These gage blocks can be combined to form any required dimension, accurate within millionths of an inch.

TWO-MILLIONTHS of an inch is approximately one fourteen-hundredth as thick as the paper on which this is printed. This gives you some idea of the remarkable accuracy of Johansson Gage Blocks — the world's standard of measurement. For these blocks, in the "AA" quality, are not permitted to vary from specified sizes by more than two-millionths of an inch.

The flattest surfaces ever produced by man are the surfaces of these gage blocks. When the blocks are wiped clean and slid one against the other with slight pressure, they cling together so tightly that the force required to pull them apart often exceeds 200 pounds.

Carl Edvard Johansson produced the first set of blocks at Eskilstuna, Sweden, in 1896.

In 1923, Mr. Henry Ford acquired the manufacturing rights for the Western Hemisphere and established Mr. Johansson and his associates in a modern laboratory at Dearborn, Michigan.

Johansson Gage Blocks have been made available for all industry where maximum precision is of first importance. Some sets are priced so low that even the smallest shops can afford them. Toolmakers use them to lay out, set up and check their work. Inspectors use them to set and check all types of inspection equipment.

More of these blocks are used in the Ford plant than any other plant in the world. This is one reason for the remarkable precision in Ford manufacture—a good reason for insisting on Genuine Ford Parts for your Ford car or truck.

GENUINE Ford PARTS

FORD MOTOR COMPANY • DEARBORN, MICHIGAN

Store-window exhibition of projects by members of the Peekskill (N. Y.) Homeworkshop Club

How to Develop GOOD PROGRAMS For Home Workshop Clubs

MUCH of the success of any home workshop club depends upon the type of programs presented at its regular meetings. Out-and-out home workshop enthusiasts are, of course, glad to have a chance to meet merely to talk over their problems and be in that atmosphere of cheery companionship which surrounds any group of men who are mutually interested in craftsmanship. Nevertheless, to hold the attention of members who haven't yet reached that stage and also to gain new members who know comparatively little about the home workshop hobby, it is essential that programs be arranged which will be both entertaining and informative.

New clubs unfortunately have more difficulty in arranging for demonstrations than old ones. Once a club is well under way, the officers and the members of the program committee learn where to look for program material. Certain members, it is soon discovered, are specialists in various lines and can give talks and demonstrations of the most helpful type. Then there are always manual training teachers, carpenters, painters, machinists, and other craftsmen in the community who, with the encouragement of an able program committee, are only to glad to tell about their work and show how to do difficult jobs. Finally, tool and machine manufacturers and their dealers, as well as firms that sell lumber, paint, hardware, and other home workshop supplies, are often glad to give demonstrations, entirely free from commercialism, for the benefit of clubs within a convenient radius of their plants or branch offices.

Official Magazine POPULAR SCIENCE MONTHLY

Those responsible for planning the programs should read the club news columns that appear each month in this magazine. They can get many suggestions from the reports of other clubs.

Now that the National Homeworkshop Guild is more than two years old, the subjects in which club members are most interested can be accurately listed. In the survey of the Guild made by Marvin A. Powell, which was summarized last month (P.S.M., Feb. '36, p. 60), one of the tables gave the units of work upon which many club members desire

Part of the large craftwork exhibition held by the Springfield (Mass.) Homecraft Club

information. There could be no better guide for arranging club programs than this list, which is given in the order of frequency with which the subjects were requested.

1. Wood finishing
2. Furniture making
3. Painting and finishing
4. Inlaying
5. Carving
6. Sharpening tools
7. Novelties to sell
8. Veneering
9. Metal work
10. Upholstering
11. Model making
12. Common tool processes
13. House repairs
14. Reading drawings
15. Electrical work
16. Leather work

It is somewhat surprising that there were twice as many requests for information on

One of the entries in the sailboat model division of the Springfield club's contest

furniture making than on common tool processes. Powell commented in his report that this would apparently indicate a knowledge of the proper use of tools on the part of a majority of the club members, but that, on the other hand, it might indicate a feeling of skill where it does not actually exist. At any rate, there is undoubtedly some reluctance on the part of club members to admit a lack of knowledge in respect to the more elementary tool operations. Club officers should make a point of having a few simple demonstrations given by an expert on such things as planing, marking, sawing, and gluing. Let the members then decide for themselves if they wish further instruction of the same type.

Another excellent source of program material, which some clubs are now beginning to develop, is based on what might be called the "project method." A committee plans a series of simple projects involving various types of work. After the list is approved by the club, each member makes each of the projects in turn and brings it to a specified club meeting, where the problems involved are thoroughly discussed. The projects themselves may be kept by the makers, sold by the club to raise funds, given away as part of the club's civic program, or otherwise disposed of. The theory is that if a member actually does the work himself, he is more likely to profit by the instruction given by the demonstrator or supervisor.

WHAT THE CLUBS ARE DOING

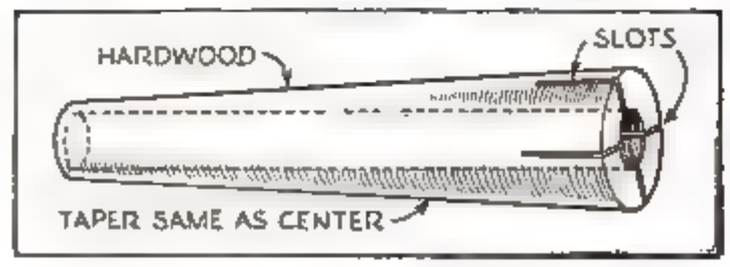
Springfield (Mass.) Homecraft Club. More than 2,500 visitors attended the second annual exhibition of the club. Prizes were awarded as follows: first grand *(Continued on page 93)*

WOODEN COLLET HOLDS SMALL TURNINGS

IN TURNING many small pieces of wood to ¼ in. in diameter or less, a collet like the one shown above will save much time.

Take a piece of hardwood, a trifle larger than the center in the headstock of the lathe, and turn it to the same taper as the center, and cut off both ends square. Place this tapering piece in the headstock and drill a hole through it. This must be done while the headstock is in motion, so the hole will be true. A good way, after finding the center, is to hold a metal-cutting drill of the required size in a pair of pliers and push it into the wood. The hole should be a trifle larger than the diameter of the piece to be turned. After the hole is drilled, remove the wood and cut two slots about 1 in. deep with a saw in the larger end of the piece.

In turning a piece to small dimensions, such



as the spokes of a pilot-wheel lamp, one end of the piece is set in the slotted end of the collet and the collet is placed in the headstock. The tailstock is used to force the collet firmly into the headstock, and as it is forced in, it grips the piece of wood. Adjust the tailstock as usual.

A piece of wood held this way can be turned to 1/16-in. diameter very easily. Use the highest speed of the lathe.—W. T. BAXTER.

BLUEPRINTS PREPARED BY EXPERTS

NO MATTER how much or little time you have for your home workshop activities, it pays to concentrate your efforts on worth-while projects. To help you do this, we offer a series of blueprints of well-tested projects designed by experts. The following is a selected list, but many other plans are available. Send a self-addressed, stamped envelope for our complete list.

BOATS

*Canoe, 16-ft. Canvas-Covered Kayak, with sail, etc., *192-193-194-R*	1.00
*Duck Boat, Folding (13-ft.), *170-R*	.50
long; weighs 60 lb.), *279*	.25
*Duck Boat, Folding (13-ft.), *170-R*	.50
High-Speed Boat for Small Outboard Motors (7 ft. 11 in. long), *257*	.25
Installing Inboard Motors, *270*	.25
*15½-ft. Runabout or "Sportboat" (outboard or inboard motor), *175-176-177-R*	1.00
*13-ft. Utility Rowboat (can be sailed or used with outboard motor), *224-R*	.50
*13-ft. Racing Runabout, *261-262-R*	.75

NOTE: Full-size patterns for any boat marked with an asterisk (*) will be drawn to order for $1.50 extra. Simply add this amount to the cost of the blueprints. About one week is required to fill orders for patterns.

FURNITURE

Chests, Treasure, *78*	.25
Child's Costumer, *179A*	.25
Coffee Table with Spiral Legs, *245A*	.25
Double-Decker Bed for Boy's Room or Cabin, *277A*	.25
End Table, American Empire, *241A*	.25
Fireside Seats (wood and metal), *266A*	.25
Floor Lamp with Tripod Base, *243A*	.25
Lamps, Three Modern, *93*	.25
Magazine Rack, Ladder-Back Style, *250A*	.25
Mirror Frame, 20 by 30 in., *246A*	.25
Pier Cabinet and Hanging Shelves, *77*	.25
Screens, Modernistic Folding, *91*	.25
Sewing Cabinets, Two, *31*	.25
Silverware Chest on Stand, *256A*	.25
Smoking Stand, Modern, *238A*	.25
Stool, Scoop-Seat, *242A*	.25
Stool, Upholstered, *240A*	.25
Table, Four-Leaf Card, *239A*	.25
Tables, Tile-Top, *249A*	.25
Tavern Table and Scroll Mirror, *105*	.25
Treasure Chests, *78*	.25
Welsh Dresser, *60*	.25

SHIP AND COACH MODELS

(Construction kits are available for some of these models. See page 8)

Aircraft Carrier—U.S.S. *Saratoga* (18-in.) and flush deck destroyer (6¼-in.), *226-227-R*	.75
Battleship—U. S. S. *Texas* (3-ft. hull), *197-198-199-200*	1.00
Bottle, Clipper Ship in, *121-122*	.50
Civil War Ships *Monitor*, *Merrimac*, and *Hartford* (3½, 5⅜, and 5⅛ in. long respectively), *258*	.25
Clipper Ship (20½-in. hull), *51-52-53-R*	1.00
Clipper Ship *Great Republic* (31½-in. hull), *272-273-274*	1.00
Constitution (21-in. hull), *57-58-59-R*	1.00
Cruiser *Brooklyn* (8-in.), *236*	.25
Cruiser *Tuscaloosa* (11¾-in.), *234*	.25
Freighter, Ocean (14-in.), *271*	.25
Galleon *Revenge* (25-in.), *206-207-208-209*	1.00
Hartford, Farragut's Flagship (33½-in. hull), special prints *221-222-R*	1.50
H. M. S. *Bounty* (8½-in. hull), *254*	.25
Mayflower (17½-in. hull), *83-84-85-R*	1.00
Motor Boat, 29-in. Cruiser, *63-64-R*	.75
Motor Boat, Working Model (20-in.), *196*	.25
Nourmahal, power yacht (8½-in.), *276*	.25
Liner—*Aquitania* (9-in.), *225*	.25
Liner—*California* (12½-in.), *251*	.25
Liner—*Normandie* (20⅝-in.), *264-265*	.50
Liner—*Manhattan* (12-in.), *204*	.25
Liner—*St. Louis* (11-in.), *231*	.25
Pirate Felucca (20-in.), *44-45-R*	.75
Privateer of 1812—*Swallow*, a Baltimore clipper (13-in. hull), *228-229-230-R*	1.00
Roman Galley (19-in.), *138-139-R*	.75
Santa Maria (18-in. hull), *74-75-76-R*	1.00
Show Boat, Illuminated (14-in.), *263*	.25
Stagecoach with Horses, *144-145-146-R*	1.00
Steamboat, Mississippi (19½-in.), *94-95-96-R*	1.00
Trading Schooner (17½-in. hull), *252-253*	.50
"Treasure Island" *Hispaniola* (7-in.), *237*	.25
Viking Ship, (20½-in.), *61-62-R*	.75
Whaler—*Wanderer* (20½-in.), *151 to 154*	1.00
Yacht *Rainbow* (7½-in. hull), *233*	.25
Yacht *Sea Scout* (42-in. racing), *106-107-R*	.75
Yacht (20-in. racing), *46-R*	.50

RADIO SETS

All-Wave Portable (battery), *217-R*	.50
Amateur Short Wave Receiver, *155*	.25
Amateur Radio Transmitter, *183-184*	.50
Five-Tube Short Wave (A.C. or D.C.), *223*	.25
Full Electric Headphone Set, *130*	.25
One Tube (battery operated), *103*	.25
Screen-Grid Set, *109*	.25
Short-Wave Converter Unit, *137*	.25

TOYS

Doll's House, Colonial, *72*	.25
Doll's House Furniture, *73*	.25
Projector for Photos and Pictures, *259A*	.25
Toy Airplane Cockpit with Controls, *114*	.25
Toy Birds and Animals, Jig-Sawed, *56*	.25
Toy Drill Press, Lathe, Saw, etc., *113*	.25
Toy Dump Truck, Fire Engine, etc., *101*	.25

MISCELLANEOUS

Drafting Table, *189A*	.25
Hand Loom, Four-Treadle, *268A-269A*	.75
Microscope Kit, Portable, *220*	.25
Night Lamp and Sewing Kit, *255A*	.25
Perpetual Star Chart, *214*	.25
Radiator Inclosures, *278A*	.25
Six Simple Block Puzzles, *65*	.25
Weather Vane, Ship Model Type, *66*	.25

Popular Science Monthly
353 Fourth Avenue, New York

Send me the blueprint, or blueprints, numbered as follows:

I am inclosing.....dollars.....cents

Name

Street

City and State

Please print your name and address clearly.

NONSKID CAMERA TRIPOD

(Continued from page 76)

two or three cuts. If the work is done by hand, a plow plane such as is used for grooving window screens is the best tool. A marking gauge and wood chisel, in the hands of a skillful craftsman, also will turn out a creditable job.

The upper section of the leg is just right for waist-high picture taking. Unless eye-level shots are desired, there will be no need of adding the second section. A sleeve bearing is inserted in the hip joint of each leg. Bore a 9/16-in. hole and insert a section of telescopic tubing. This is so called because one size makes a sliding fit over the next smaller size. The 9/16-in. tubing makes a perfect bearing surface for the ¼-in. threaded rods. Start it in by lightly tapping with a wooden mallet, then adjust a C-clamp and squeeze it into place. Start from the upper face. The sleeve should not go all the way through, or it will interfere with the clutch surfaces.

List of Materials

1 pc. hard maple 1¼ by 2 by 2 in. for tripod head.
3 pc. mahogany 1 by 1 by 43 in., and 3 pc. 1 by 1 by 26 in. for legs.
3 U.S.S. 20 brass machine screws, ¼ by 3 in.
4 U.S.S. 20 brass machine screws, ¼ by 1¼ in.
6 wing nuts and 9 washers for the screws.
6 pc. brass strapping, 1/16 by 1 by 5 in.
3 ball-type friction catches, ¼ in.
9 roundhead brass wood screws, ½ in.
3 pieces of telescopic tubing, 9/16 in. in diameter and ¾ in. long.

Now cut the tongues on the lower leg members to give a sliding fit, not too loose. The members should make contact on the lips of the groove, not the bottom of the tongue.

Bend the metal strapping as shown, fitting each piece to the leg individually. A small vise and wooden mallet are the only tools required. Drill the required holes and fasten the strapping.

The friction catches give an audible indication when the legs are extended to maximum, and also automatically equalize the length of the legs.

The tripod may be stained if desired, but do not paint or varnish it. Apply a coat of hot beeswax, rubbing it well into the wood. This acts as a lubricant for the channels, does not scuff or scar, and presents a professional appearance. Rubber-headed tacks make good feet.

Professional photographers agree that good pictures may be obtained consistently only with the aid of a tripod. When the petty annoyance of a temperamental tripod is eliminated, the photographer is enabled to select better action and composition.

While not shown, because it was being used on the camera with which the pictures were being taken, a ball-and-socket joint between tripod and camera increases the flexibility to a very large extent.

The hardware and fittings for each leg joint

WALNUT BRACELET WITH POLKA-DOT INLAYS

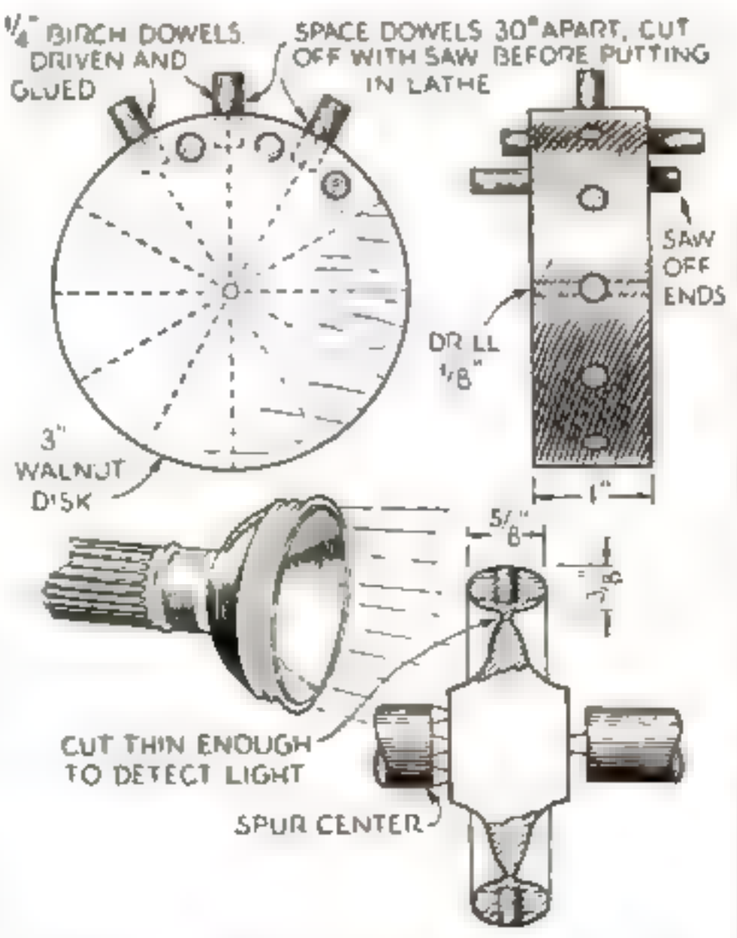
The highly polished walnut is relieved by ivory-colored dots, which are birch dowels

AN ATTRACTIVE type of wooden costume jewelry is represented by this walnut bracelet, which was made by Russell Hand, of Pasadena, Calif. The ivory-colored birch dowels heighten the effect with a polka-dot design.

First cut a disk of 1-in. walnut, about 3¼ in. in diameter to allow for a 3-in. finished diameter. A ⅜-in. hole should be drilled in the center as true as possible. Divide the disk into twelve 30-deg. segments with a pencil, and drill twelve ¼-in. holes ¼ in. deep radially. Birch dowels, which must fit very snugly, are then glued in. The lateral dowels shown are put clear through the disk, and the ends of all sawed off before setting the work in the lathe.

Mr. Hand does not turn the bracelet as a faceplate job. The *(Continued on page 85)*

The waste stock is turned so thin just inside the bracelet that light shines through



The blank with dowels inserted and the finished turning before the center is cut away

WALNUT BRACELET WITH POLKA-DOT INLAYS

(Continued from page 84)

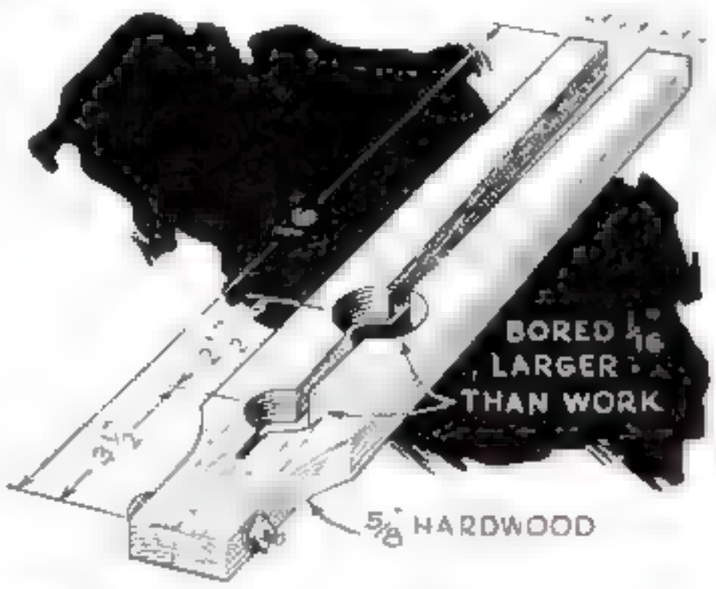
blank is set up between centers, as illustrated, and the rim is roughed down to approximately ⅜ by ⅝ in., oval in section and undercut, but with enough stock in the central portion to prevent its breaking away. The cutting is stopped as soon as the web is so thin that a strong light, such as from a flash light, can be seen through it.

The finishing is done entirely with garnet paper, working down from coarse to finer grades as the exact shape is approached. Garnet paper is more satisfactory than ordinary sandpaper for this purpose. Continue the smoothing with fine steel wool. The bracelet is now removed from the lathe and the central portion cut away with a sharp knife. The inside of the ring is then finished on a small sanding drum.

Next apply two coats of shellac, steel-wooled after each coat has dried. Follow with two coats of a high-grade spar or marine varnish. Allow this to harden for three or four days and then rub down with light machine oil and rottenstone. This final polishing, of course, is best done on a small buffer, if available.—H. S.

WOODEN CLAMP HOLDS SMALL ROUND PARTS

IT IS not easy to hold a small, round piece of wood under a drill press or other tool, but a clamp may quickly be made for this purpose as shown. It should be cut from hardwood about ⅝ in. thick and holes bored 1/16 in. larger in diameter than the work to be clamped.—L. R. B.



The round parts to be drilled are inserted in a hole and held by squeezing the handles

WORDS MADE TO ORDER FOR THE STRANGE LANGUAGE OF THE CABLES

(Continued from page 23)

in which payment was to be made. Mr. Peterson revised the code to put that additional information into the first word. Like the register company's code, it was expanded from about 100,000 words to 400,000.

New developments in industry and commerce are constant causes of code revisions. William J. Mitchell, revising a general export company's code, had to put in a whole new series of phrases about beer cans. When the code was first made, beer was not packed in cans.

On another occasion, bringing a bank code up to date, Mitchell discovered that more than fifty new code words were needed to describe transactions in the newly introduced "barter money" of a European country.

CODE makers often find single words needed to convey surprisingly odd statements. Cyrus Tibbals, building a code for a brokerage concern, studied its cable correspondence carefully, and arranged a tremendous vocabulary. An officer of the brokerage house, glancing through it with pleasure, suddenly complained:

"You haven't any word for: 'I am sending you fifty dollars. Happy New Year.'"

Tibbals recognized this as a real oversight. Many of the firm's clients sent New Year's Day gifts to relatives in Europe. He put in a complete set of code words to express New Year's greetings, accompanying various amounts of money.

The long, important messages crammed into single code words, and the consequent dangers of serious misunderstanding through slight errors in transmission, always have put heavy responsibilities upon code makers.

Some forty years ago, a wool merchant, using a code of secret words mixed with plain language, wired an associate in the West, "Bay 500,000 pounds."

The word "bay" meant: "I have bought."

The message, when delivered, read: "Buy 500,000 pounds"—and the dealer did. The price of wool dropped, and the merchant lost $20,000. He sued the telegraph company, but the United States Supreme Court granted him only a refund of the telegram's cost. The judges said he shouldn't have used such a risky code.

As long as dot-and-dash systems were in general use, expert code makers avoided code words which could be changed into other code words by simple errors. They had tables of fifteen or more dangerous similarities. Although these dangers have been eliminated by typewriterlike transmitting equipment, no telegraphic device is absolutely error-proof. Operators still make occasional mistakes. Electrical disturbances similar to radio static sometimes cause letters to be lost in transmission, or changed entirely into other letters. Receiving instruments sometimes go out of order and substitute one letter for another until the trouble is discovered.

A ONE-LETTER error in a broker's message, a few months ago, caused him to buy a certain stock for one customer, instead of selling it for another. When the mistake was discovered, two hours later, the stock had fallen in value, and the broker filed a claim against the telegraph company for the difference.

Another broker had a happier experience. An error caused him to buy more of a stock than had been intended, and the stock went up. The broker tried to give his accidental profits to the telegraph company.

"If I had lost, I would have expected you to make good," he explained. But the company would not accept it.

It is to guard against such errors that most professional code builders make every word differ from every other by at least two letters. Then, if any single letter is transmitted wrongly, the person receiving the message will know an error has occurred, because the garbled word will not appear anywhere in the vocabulary.

It is this principle which makes the new codes capable of greater accuracy. If the compiler does not wish to use the largest possible vocabulary, he can choose fewer words, with greater differences between them, providing an added safeguard against error.

WITH the very start of electric telegraphy, codes came into use. At first they consisted of ordinary words with secret meanings. Code makers soon began to reach out for larger vocabularies, and telegraph companies fought to exclude long, cumbersome words that would confuse and retard operators.

When cables were laid across the ocean, about fifty languages became acceptable, the only limitation being that words must not contain more than six syllables. Operators had their hands full, and their eyes and ears too, with such words as "Chinesisklutningsdon"—which, after all, had only six syllables.

An international telegraphic conference limited code words to eight languages, and disputes began to arise between senders and cable clerks over words that sounded real, but couldn't be found in any dictionary. Code builders were making them up.

The real importance of the change from plain language to the latest artificial words can hardly be realized without comparisons. A modern code can contain more five-letter "words" than all the words, of all lengths, listed and defined in an unabridged English dictionary. In the eight approved languages—English, French, German, Dutch, Italian, Spanish, Portuguese, and Latin—it was estimated that there are only 160,000 words of ten letters or less, differing from one another by at least two letters!

Nearly all large code makers build their vocabularies by special formulas. And, by a remarkably ingenious arrangement, the same tables which form the words, serve to correct errors which occur in transmission.

When a person receiving a message comes upon a word which is not in the vocabulary, he does not wait costly hours while the cable company finds the mistake. Instead, he turns to his "error finder," or "mutilation table,"—and finds the right word.

BEFORE a code maker chooses a single code word, he arranges a table. Usually it is in three parts: One part for the first two letters, one for the third, and one for the last two. The formula for combining the three parts makes it impossible to pick a word with less than a two-letter difference from every other word. And when any four letters of a word have been selected, there can be only one choice for the fifth.

That is the amazing principle by which a transmission error involving any one letter can be corrected. Assuming the first four letters to be correct, the person who received the message speedily finds the fifth. Then he assumes the first three letters, and the fifth, to be right. He quickly finds the fourth. He has only five such operations to perform, and the sense of the message tells him which of the reconstructed words is the right one.

All on one page, the remarkable "mutilation chart" really is the birthplace and the permanent identification bureau of nearly half a million words. Not words in the old sense, but words of the new language carrying messages of commerce and industry around the world.

VITAL PROBLEMS THAT CHALLENGE INVENTORS

(Continued from page 15)

million pounds of bromine a month from the ocean, sucking up 26,000 gallons of water a minute. It points the way to work for the future.

More than three percent of the two quintillion tons of ocean water is made up of solid matter. About eighty percent of this material is common salt. The rest includes all the minerals known to man. Some years ago, a German scientist took samples of sea water, at different points, all the way from the arctic to South America. Every sample contained minute quantities of gold, with the greatest concentrations in the arctic. Oysters extract copper from the sea. Man has yet to duplicate the feat and make it pay. In the realm of ocean research, there are problems galore — each an opportunity for discovery or invention.

ON LAND, improved methods of extraction would turn every clay bank into an aluminum mine. Present processes can use only the concentrated ore known as bauxite. Cheap plastics, new solvents for cellulose, and the perfection of machinery for creating an ideal artificial climate within office buildings, are other problems to be overcome by science.

Television in natural colors is a goal which still eludes the inventor. For years, television has seemed on the verge of practicability. But it still remains among the items listed with the unfinished business of science.

Conquering static in radios and developing a commercial telephone which will record the sound of a voice with the least possible distortion are other objectives to be attained. If superefficient radio tubes can be devised, tiny receiving sets no larger than watches can be carried about in vest pockets to pick up programs and personal messages. Until it is possible to talk to any person, anywhere on the globe, science will not have completed its work in the field of communication.

We know virtually nothing about the effect of X rays and radium in altering the hereditary characteristics of plants. We are just skirting the borders of weather forecasting, of scientific farming, of prolonging human life. Thousands of synthetic products, now undreamed of, may come from the laboratory. Rocket flight is yet to be attained. New and safer anesthetics lie ahead. And, in each of these unsolved problems of science, there lies an opportunity which research men of the future may grasp.

FIVE centuries ago, Leonardo da Vinci, the Italian painter and scientist, made twenty-one discoveries and inventions which are rated as eternally important. Edison is credited with only six. In the days of Leonardo, people thought that science had reached its peak. But, of course, the judgment was wrong. Today, as in 1490, science presents a world of unbounded opportunity. Each peak that science attains merely serves as a vantage point, revealing vast, unexplored realms that lie ahead.

CHEMISTS MUST REPLACE WAR-ESSENTIAL IMPORTS

DESPITE its vast natural resources, the United States is largely dependent upon the outside world for many important commodities, a recent report to the American Chemical Society shows. Essential materials of which we would lack an adequate supply if blocked in war include antimony, chromium, manganese, mercury, mica, nickel, rubber, tin, tungsten, and wool. In such a hypothetical emergency, according to the report, chemists would have to develop new metal alloys and suitable substitutes for rubber, wool, and other indispensable products as vital factors in national defense.

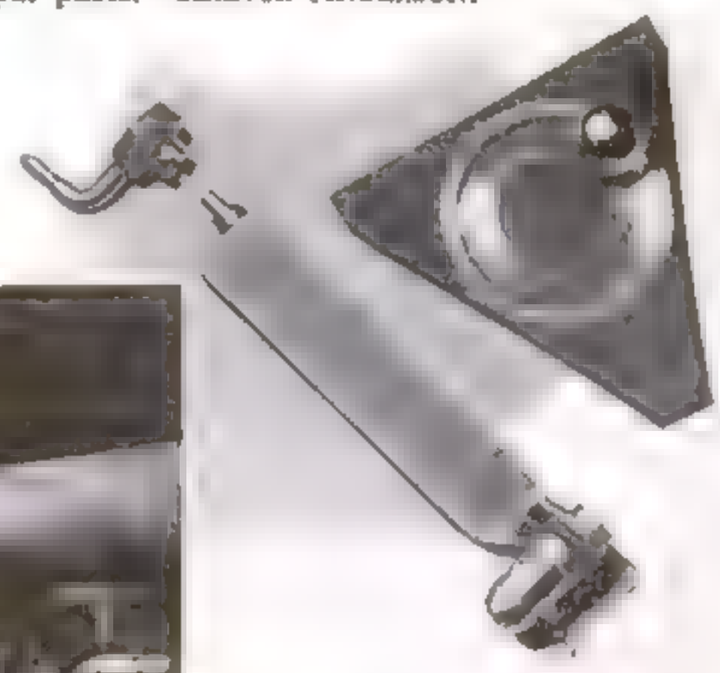
ADJUSTABLE TOOL FOR TURNING RADII

THE adjustable radius turning tool illustrated below turns radii from ⅜ to 1¾ in. The tool bit in the revolving head is moved by means of the handle at the other end. The bit is set to the required radius by measuring with micrometers from the tip to the back of the holder.

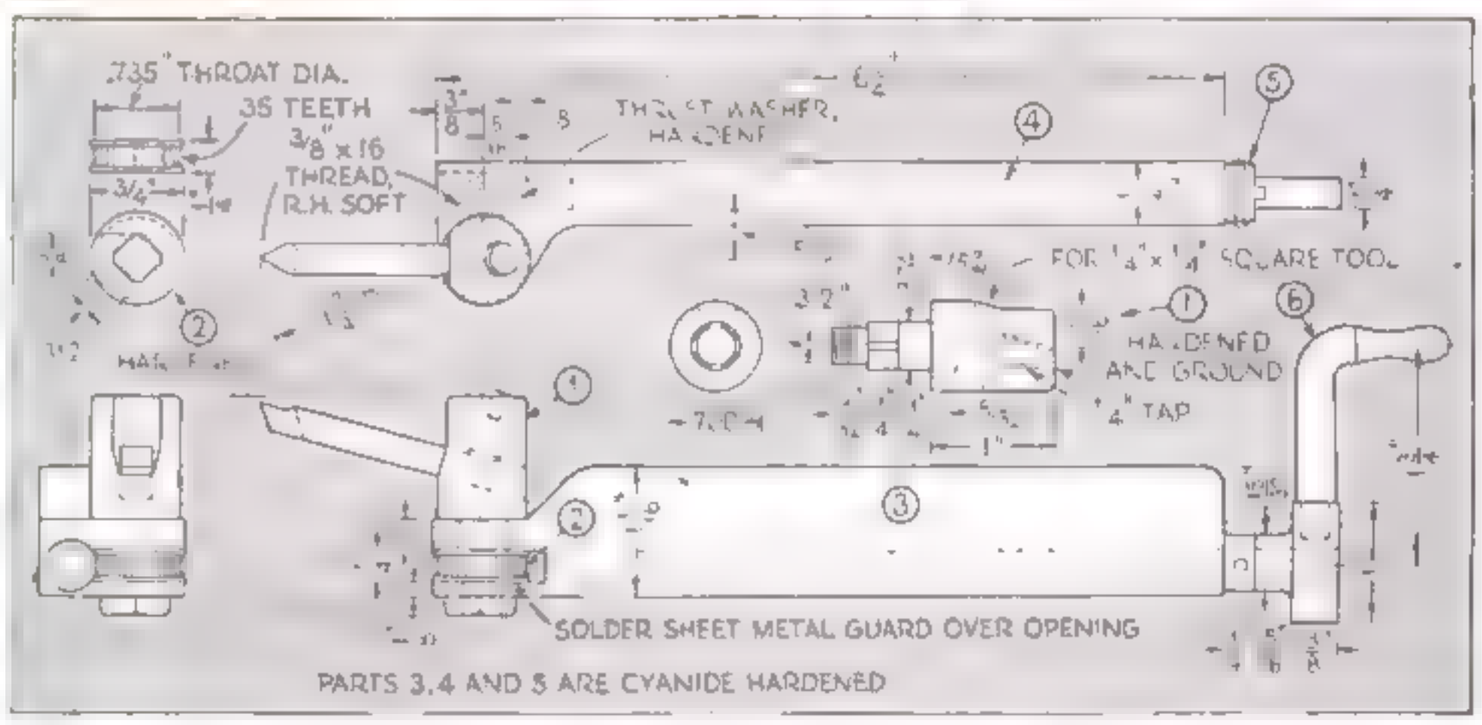
The large photograph shows how the tool is used. It is in the working position after being used to turn the radius on a worm wheel. The other photograph illustrates how the handle is detached so the tool may be passed through the lathe tool post. In this view is also shown a ball race as another example of the type of work that may easily be done with the tool

The materials required are: 1 pc. tool steel .700 in. diameter by 1 25/32 in. for the part marked *1*; 1 pc. tool steel ¾ in diameter by ¼ in. long for part *2*; 1 pc. cold-rolled steel 1 1/16 by 1 25/64 by 6¼ for *3*; 1 pc. cold-rolled steel ⅜ in. diameter by 7 3/16 in. for *4*; and 1 pc. cold-rolled steel 15/32 in. diameter by 11/32 in. for *5*.

The drawings below show the assembled tool and give all essential details of its principal parts.—HALVOR ANDERSON.



At the left the tool is shown in position after having been used to turn the radius on a worm wheel. The photograph above illustrates how the handle is detached so the tool may pass the tool post. A finished ball race is also shown



Assembly views of the adjustable radius turning tool and details of the principal parts

BOOT COVERS ON SKIS PROTECT FEET FROM WET SNOW

THE two pairs of homemade ski covers illustrated in the photograph at the right are designed to protect a skier's feet from wet snow and prevent the snow from balling up under his boots, which is one of the common annoyances that reduce the pleasure of the sport. The pair at the left of the photograph were made of leather from an old boot top. Any similar scrap leather may, of course, be used. It was cut according to the diagram, inverted, and tacked across the top of the ski, then turned over and tacked to the edges, and finally laced to the footgear strap with leather laces.

The rubber ski covers, which are shown at the right of the photograph, were made from an old inner tube and put on by tacking on the right side across the top, along the edges, and in one place on the edges behind the strap. The skis in both cases were 3 in. wide. It is a simple matter, however, to fit such covers to any skis.—L. F. COLLINS.

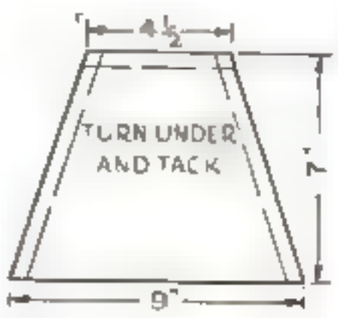


Diagram for cutting the leather to make covers for 3-in. skis

PRIZE-WINNING WALNUT TELEPHONE STAND

(Continued from page 69)

being well sharpened and burnished, the scraper plane will give a smooth surface on the most crooked grained wood, which needs only a light sanding with a fine abrasive (No. 4 or finer). Garnet paper is far superior to sandpaper both in cutting and lasting properties. Finish with No. 8 paper and you will have a surface literally as smooth as glass.

The faces of all mortise-and-tenon pieces should be finish sanded before joining. After the glue is applied and the piece driven up and clamped together, be sure all glue drips are washed off. Use warm water, a small stiff-bristled brush, and plenty of soft rags, with a sharpened hardwood stick to get into the corners. The water soon dries out and the slight roughness caused by it is easily removed with a little No. 8 garnet paper. If glue is left to dry in the corners, it must be subsequently removed with a chisel, which inevitably leaves rough spots.

THE mortises and tenons should be marked with a scratch gauge, preferably a double mortise gauge. Always gauge from the same corner of the piece. The amateur rarely has sufficient skill to make an accurate tenon by sawing directly to the gauge marks and knife marks on the shoulder, although this is, of course, the time-honored method. However, the home worker can easily overcome lack of skill in handling the saw by sawing with a slight finish allowance, say about 1/32 in., and then trimming to the mark with a sharp chisel. In cutting the mortises, be careful to avoid undercutting the sides, which makes the mortise too wide at the bottom. I usually rough cut by eye and then make the finishing cuts on the sides and ends, checking with a 4-in. combination square. The mortises should be cut first and the tenons fitted to them, so that they go in place with a few light taps of the hammer.

The holes in the legs for the bottom rounds must be located accurately and bored true. Do not attempt to bore these holes without a jig; the most skilled workmen could not do it accurately. The jig shown in the drawings can be quickly constructed and will give accurate results.

The drawers should be made after the frame is joined. Cut the drawer fronts to fit, with about 1/32-in. clearance vertically and no clearance horizontally. The dovetails in the sidepieces are marked with knife, bevel, and try-square and then cut accurately to the mark. Next clamp the sidepiece to the end of the drawer face and scribe with a sharp knife as in one of the sketches. By making a very slight bevel on the tail edges and inclining the knife blade outward as shown, the scribed notches will be just a shade smaller than the tails, so that when cut, they will form a snug and accurate fit. Cut the notches to a depth equal to the side thickness plus 1/64 in; after gluing together, the projecting 1/64 in. of the face end is planed and sanded off flush with the side, leaving a smooth surface and providing the necessary horizontal clearance between drawer and table frame.

CUTTING dovetails is one of the fine arts in cabinetwork. Those who are in a hurry or who cannot make a chisel behave, should devote their time and energies elsewhere. However, any one who can handle a chisel can make a good joint by adhering to the following principles:

1. Proper layout, all lines being accurately scribed with a knife.
2. First rough cut, leaving a scant 1/32 in. for the finishing cut.
3. Check all surfaces with square and bevel.

Old-time cabinetmakers laid out dovetails with very wide *(Continued on page 90)*

PRIZE-WINNING WALNUT TELEPHONE STAND

(Continued from page 89)

tails and small pins. My preference is to make the tails and the notches equal, as in machine dovetails, because it is apparent that maximum strength is obtained in this way.

Dovetails are cut at various angles. My method is to draw a right-angled triangle with one leg ¾ in. long and the other 4 in. long and then set the bevel to correspond.

Lack of experience need not prevent one from making a good dovetail joint. Start with a couple of inches extra length on the drawer face and sidepieces, and if the first joint is spoiled, it may be cut off, leaving the stock still long enough.

After cutting the dovetail joints, fit them together without glue and plane the bottom edges flush, making sure the bottom edges of the sidepieces are parallel. This precaution is important, as otherwise the drawer will be winding and cannot be properly fitted into the frame and guides. Now take apart the face and sides and cut the grooves for the bottom and the back. Then cut and fit the back, after which the face, sides, and back can be assembled with glue. Immediately after clamping up, check carefully for squareness; any slight deviation can be corrected by light taps of the hammer before the glue sets.

The drawer bottoms are put in place without glue, being held by screws into the back. They can thus be removed to facilitate finishing. The grain in the bottoms is parallel with the drawer face. Clearance for swelling is provided by leaving about 1/16 in. between the edge of the bottom and the bottom of the groove in the drawer face. The bottom should fit the grooves just loose enough so it can be pushed into place with the hand. After the drawers are completed, fit the drawer guides in place.

The top is held fast to the frame at the centers of the frame sides by screws through small blocks. At the corners, the top is held down by screws through slotted angle irons, permitting it freedom to shrink and swell with changes in atmospheric moisture. If the top is fastened rigidly at the corners, it is apt to buckle or crack open.

The matter of finish depends on the preference of the maker. Stained finishes are usually ugly, like other imitations. No amount or kind of stain will turn birch into mahogany, or deceive any but the most careless observer. An oil-wax finish on dark-colored woods is handsome; moreover it is easily applied, durable, and requires only an occasional rewaxing. Mix equal parts of *(Continued on page 91)*

List of Materials

No. of Pieces and Description	Dimensions	Material
1 Top	27x18x1	Walnut
4 Legs	28¼x2x2	"
2 Sides	14⅛x9⅛x1⅛	"
1 Back	23⅛x9¼x1⅛	"
2 Drawer spacers	23⅛x⅞x1⅛	"
2 Rounds, front and back	22¾x1¼x1¼	"
2 Rounds, sides	13¼x1¼x1¼	"
2 Drawer faces	21⅛x3¾x13/16	"
4 " sides	14 9/16x3¾x7/16	Quartered white oak
2 " backs	20¾x3⅛x7/16	" "
2 " bottoms	20¼x14 3/16x7/16	" "
2 " guides	12¼x3⅛x⅜	White oak
4 " "	13¾x⅞x1⅛	" "
2 Top blocks	3x1 3/16x⅝	" "

NOTE: All dimensions are given in inches and are finished sizes, therefore allow for finish.

MISCELLANEOUS

4 antique brass drawer pulls
4 steel angle irons, 1 by ½ in.
4 roundhead steel wood screws, ⅜-in. No. 10.
4 washers for No. 10 screws.
4 flathead steel wood screws ⅞-in. No. 10; 10 of 2-in. No. 10; 12 of 1¼-in. No. 10; and 8 of 1-in. No. 6.

Old Bill SAYS:

IF A CORRECTLY ground wire drill cuts large, the first thing to do is to check up the concentricity of the chuck. If you find no trouble there, you had better shorten the drill ¼ to ½ in. and repoint it.

• • •

Geared scroll chucks must operate freely, and they should be kept so with a good cleaning out every four or six weeks. They will not only give better results, but will last three times longer.

• • •

It often pays to resharpen a $1.50 high-speed steel power hack-saw blade. It will stand three or four grinds as a rule and will perform practically as well as new. All you need is a beveled bakelite cut-off wheel, a work rest, and a little practice on a discarded saw.

• • •

A man who attempts to sharpen free-hand a set of die-head or collapsing tap chasers is simply a boiler maker.

• • •

Narrow, thick bolts are generally preferable to wide, thin ones.

• • •

A supply of assorted scrap drill-rod stubs is an economical necessity in any tool room. This material can be had from drill manufacturers at small cost.

• • •

Don't attempt to use carbide-cemented tools on regular machines unless all wear and vibration is entirely eliminated. Cutting carbides are tough, but very brittle.

PRIZE-WINNING WALNUT TELEPHONE STAND

(Continued from page 90)

genuine turpentine and boiled linseed oil, and apply liberally with a soft brush; allow half an hour to soak into the pores and then wipe off with rags. In two or three days make a second application, using a larger proportion of oil. Allow a week or ten days for the oil to become thoroughly hard and then give two coats of good wax. On light-colored woods oil should not be used; wax alone (or applied on clear lacquer) will give a beautiful finish. The rubbing surfaces on the drawer guides should be sanded smooth and waxed. The drawers, being finished in the same way, will thus slide very easily. The underside of the top should be smoothed and given the same finish as the rest of the piece.

I have supplied the reader with a detailed description of how to make a telephone stand, together with drawings wherein every dimension is specified. Having described the thing thus exactly, let me add that I never made anything strictly to a drawing (not even my own), and I would hardly suppose any one would follow my drawings to the last iota in all respects. There is the design—change it, improve it as you will, but don't substitute stained gumwood for walnut, dowel pins for mortises and tenons, or nails for dovetails.

BALSA-WOOD DIVISIONS FOR FITTED CASES

THE neatest way to carry a group of tools or instruments required for one particular kind of job is in a fitted case. Radio repairmen, amateur microscopists, photographers, and followers of many other hobbies find a fitted case convenient because it keeps the instruments or tools in good condition and reveals at a glance if anything is missing.

As ordinarily made with wooden blocks and wooden partitions, a fitted case is both heavy and hard to construct. The solution is to use balsa wood. So light is it that you can use thick, strong partitions and solid blocks as supports without worrying about the weight. And it cuts so easily with a sharp penknife that there is no difficulty in shaping the blocks to fit the objects they support. Any good glue or cement will hold the balsa wood in place and join pieces for odd shapes.

Fitting balsa-wood blocks to the interior of a case so that it will hold special equipment

The surface of balsa wood is so soft that it should be protected by a covering such as velvet or billiard cloth. Applying the covering is easy, but does take a bit of patience. First, pieces of velvet are cut to fit the various surfaces. Then the surfaces are painted with the adhesive and the pieces of velvet smoothed into place. Do not try to overlap the cloth, but make butt joints. If any adjoining pieces do not quite meet, cut a thin strip to fill the gap.—A.P.L.

PUMP VALVES CUT FROM HEAVY INNER TUBES

DURABLE and inexpensive valves for water pumps of the type used in rural communities may be made from a piece of rubber cut from a heavy inner tube. They take only a few minutes to make, yet my experience has been that they outlast ordinary leather valves and also give a better seal so that the pump needs no priming.—WILL E. SMITH.

HOME WORKSHOP CLUBS

(Continued from page 81)

prize, a high-grade shaper, to Glenn E. Flint for an inlaid tilt-top table; second grand prize, a circular saw, to G. Wesson Clow for a model of the *Flying Cloud;* third grand prize, a drill press, to K. H. Pond for a working model of a steam roller. The other awards were: Woodcarving—G. M. Kerns, Mr. Flint. Novelties—Mr. Flint, Dr. Frank N. Seerley, L. W. Beatty. Cut metal—Howard Shrude, Irving Bailey, William Shrude. Wood turning—A. Racine, Mr. Flint, Mr. Kerns. Power boat models—Charles Kroll, F. W. Wilbur, Henry Landry. Sailboat models—Fred Arnos, Earl C. Gilman. Historical ship models—Mr. Clow. Inlaid wood—Mr. Flint, Charles Svec, C. H. Morrell. Furniture—Mr. Kerns, Elwood B Hovey, F. W. Wells. Braided rugs—E. C. Taylor, J. H. Hamm, Mrs. Housman. Crochet work—Mrs. Housman, Mrs. B. A. Rivest. Hooked rugs—Mrs. George Grace, Mrs. E. G. Taylor, Mrs. Thomas Dyer. Crocheted bedspreads and quilts—Mrs. Grace, E. Maxwell, and Anna Zilka. Hardanger work—Mrs. Grave Paintings—Leslie G. Mann, Walter Les, Mr. Clow. A number of the club members made articles to be auctioned off at the exhibition for the benefit of a Springfield toy fund

Keep a Photo Record of Your Club

WHEN your club makes or does something of unusual interest, have some photographs taken and keep them in an album as part of the club records. Send the best of them to the Guild Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, N. Y. As many as possible will be published.

Capital Homecraft Club, Washington, D. C. A recent meeting was held in the well-equipped shop of Henry J. Robb, who has constructed a coffee table and a cradle from the wood of a walnut tree which he himself felled and then had sawed into boards.

Brunswick (Me.) Homeworkshop Club. An entertaining program was given by Virgil Ward before the club members in the physics lecture room of the Science Building, Bowdoin College. . . . A visit is being planned to the shops of an ironworks company in Bath.

Kingsville (Texas) Homeworkshop Club. Finishing woodwork was the main topic at a recent meeting in the home of E. V. Yeargan, president of the club. The question came up of making use of some of the many logs of rare woods that have been washed high and dry by tropical hurricanes on Padre Island, a narrow, desolate strip of land extending from Corpus Christi to Brownsville. This section has been visited by various members, and strange woods have been found which could not be identified locally. The big problem is in bringing the logs to Kingsville, as nearly all of them are too large to be moved by ordinary means.

Fargo (N. D.) Homecraft Guild. The club began 1936 with thirty members, with good prospects for the addition of ten more within a month or two. The following officers were elected for 1936: Ben V. McCaul, president; O. M. Mickelson, vice president; John C. Pollock, secretary-treasurer, and Gunnar Helland, librarian. The governors are O. M. Eide, Chris Sorenson, and D. O. Hazeldahl. . . . The club voted to *(Continued on page 94)*

HOME WORKSHOP CLUBS

(Continued from page 93)

build and equip a workshop for the receiving home of the North Dakota Children's Home Society in Fargo. The necessary benches, vises, hand tools, lockers, and other equipment will be provided.

Topeka (Kans.) Homeworkshop Club. Dr. S. T. Millard has been elected president for 1936; Dr. O. L. Erickson, vice president; H. B Schwartz, secretary; Richard P. Daniels, treasurer, and Dr. E. W. Irish, librarian. The members of the board of governors are Fred U. NovoGradac, Steve Smith, and C. V. Carlson . . . The club's informative monthly news bulletin, of which Richard Kerr is the editor and Charles E. Faulk the mimeographer, is now well started in its second year.

Fall River (Mass.) Homecraft Club. The first and third Sundays of the month have been fixed as the meeting days of this newly organized club, which is open to any home workshop enthusiast more than eighteen years old. George Legault is president, and Oscar Briand, secretary-treasurer.

Club des Artisans Amateurs, Trois-Rivières, P. Q., Canada. A demonstration on how to use planes and how to get a satin finish on wood turnings was given at a recent meeting by Joseph Baril, a guest of the club. The regular monthly exhibition was assigned to J. Henri Dubé, secretary of the club, who displayed three carved walnut silhouettes. A bookcase was presented to the club by some of the members as a club project.

Homecraft Club of Pittsburgh, Pa. Although only a little more than a year old, this club has a membership of eighty-eight and is growing rapidly. . . . A year-end display of the crafts and hobbies of the members was held. The club has established a policy of having its contests judged by outside master craftsmen with the understanding that craftsmanship alone is to count. In other words, a footstool receives just as much consideration as a pretentious piece of furniture, provided it shows equal skill in construction. . . . At a recent meeting, sixty-three members and thirty-three prospective members attended. A demonstration was given on eight woodworking machines, the feature of which was an explanation of the so-called "line-production" idea of arranging the machines in a workshop to facilitate the work. All present at this meeting were presented with pocket oilstones and numbered ticket stubs. Duplicates of the tickets were drawn for a door prize, which was a high-grade jack plane. J. H. Paterson is president; M. A. Kelly, secretary; C. A. Herman, treasurer, and C. A. Lynch and P. W. Mathews, governors.

Homecraft and Modelmakers' Guild, Richmond, Va. Glass blowing, engraving, all types of model making, and the more usual crafts of furniture making, wood turning, leather working, and machine-shop work are included among the hobbies of the fifty-seven members of this club. . . . The output of toys was greatly increased this season over last. This is the third time the club has made toys for the needy since its organization on November 28, 1933. Much of the necessary material is donated by Richmond lumber dealers and hardware merchants. . . . The annual exhibition was held in the windows of the Methodist Publishing House. M. T. Turner, manager of that store, is one of the club's most enthusiastic members. . . . The officers are Dr. C. L. Albright, president; R. H. Athearn, vice president; F. W. Harrison, secretary-treasurer, and M. E. Ryder, librarian. Meetings are held on the second Friday of each month at the Virginia Mechanics Institute.

Creston (Iowa) Homeworkshop Club. One hundred and nine toys were turned over to the Creston Fire Department for distribution among the needy, and several lamps and ash trays donated to the Elk's charity ball for sale to swell the Christ- (Continued on page 95)

HOME WORKSHOP CLUBS

(Continued from page 94)

mas dinner fund. . . . A demonstration was given at a recent meeting on wood carving and the use of a high-speed carving machine. At another meeting the making of ornamental objects from Keene's cement was explained. The demonstrator brought to the meeting the blank stock for a lamp, which he had molded the day before, and turned it on the lathe. One of the club members supplemented this program by showing how to turn and carve alabaster. On another occasion the instructor showed with a projection machine a number of projects from the 1935 issues of POPULAR SCIENCE MONTHLY. This enabled the members to study the characteristics of the various designs in their greatly enlarged form. The instructor told the members the important things to look for; and furniture, models, novelties, and celluloid work were thoroughly covered.

Ashtabula (Ohio) Homeworkshop Club. The club opened three new club rooms on East Forty-six Street with a display of craftwork. Members of the Cleveland, Ohio, and Erie, Pa., club were invited, and after the meeting a luncheon was served. One of the features of the exhibition was the carved flat-top desk by Merle J. Eddy that won third prize for furniture made with hand tools at the National Homeworkshop Guild exhibition in Chicago last year.

SILENT MODEL RAILWAY

THE thundering noise of the average model railway layout can be permanently eliminated by using sponge rubber, preferably ⅜ in. thick, cut with shears from a kneeling pad into rectangles 1¼ by 2¾ in. Place one piece under each end tie, drill ⅛-in. holes through the tie and the rubber on both sides of the center rail, and force ¾ by 3/32-in. machine screws through the holes. Set the nuts deep into the rubber so that contact with the platform will be impossible when the screws are cut off flush. When the tracks are prepared in this way, lay them by driving 1-in. No. 18 flathead brads through the outer edges of the cushions into the platform. Drive the brads deep and see that they do not touch the ties. Bank the curves by wedging extra cushions between the platform and the tie cushions. Insulate switches and crossovers by cementing cushions to their bottoms. The cushions may be concealed with gravel or other suitable material.—WALTER STROTHMAN.

FREE BULLETIN TELLS HOW TO START CLUB

WHY not have the honor of organizing a home workshop club in your own community, if one is not already in existence? It is very easy to do as has been so clearly shown by the success of the many clubs already organized.

The best method of starting a club is outlined step by step in a free bulletin you can have by filling out the coupon below. Send for it at once.

Home Workshop Department
Popular Science Monthly
353 Fourth Avenue, New York, N. Y.

I am interested in the home workshop club idea and wish to know how to organize a club. Please send me this information in the large self-addressed and stamped envelope I am inclosing.

Name .. ..

Address .....

City ..... State .....

(Please print very clearly)

GLUING SPLIT PADDLES AND OTHER THIN WOOD

An improvised clamp for gluing split wooden parts such as the blade of an oar or paddle

CLAMPING a thin piece of wood for gluing so that it will not warp is always difficult. If the thin piece is a split canoe paddle or the blade of an oar, and you are without the usual tools, it seems next to impossible.

Any basement, boathouse, or camp will have the essentials for making a good job—light cord, a few nails, a knife and hatchet, and some sort of waterproof glue. The repair of a paddle will be described, but the same method is, of course, applicable to thin panels or any similar type of work.

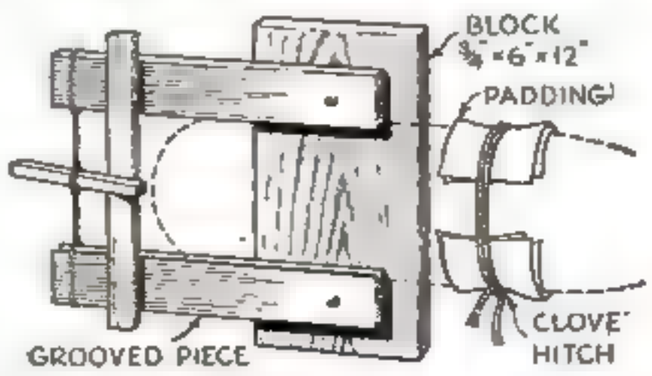
Pad the edges of the blade and place a clove hitch just beyond the end of the split to prevent it from running further. Then mix your glue, if you use the casein variety, which is best for the job in hand. While the glue is setting, look about for some waste planking—one piece about ¾ by 6 by 12 in. and two ¼ to ½ in. thick by 2 by 12 in. Groove the inner edges of the thin pieces, making sure that these edges are straight.

Lay the blade lengthwise along a small round stick and press the edges downward to open the split while glue is rubbed in with a circular motion of the forefinger, first from one side and then from the other. Wipe off all excess glue. Lay the paddle blade on the heavier piece of scrap wood and press the grooved edges of the other pieces against the edge of the blade, allowing 2 or 3 in. to project, as shown. Nail the inner ends to the heavy cross member with one nail each. Now take a few turns of light line around the projecting ends of the grooved pieces, draw taut, insert a short piece of stick, and twist until the glue squeezes from the split, indicating a tight joint. To hold the tension without forcing the blade out of shape, lay a stiff stick across the grooved sidepieces for the tension bar to rest against.

Wipe off excess glue and allow to set for a while. Then wipe on another coat of glue to fill any small edges of the crack and again wipe away excess.

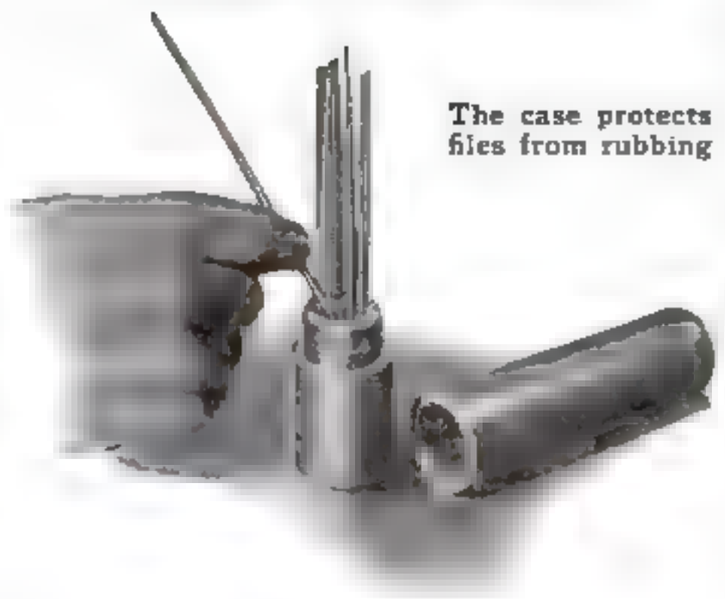
The joint will be dry in twenty-four hours, or sooner with some of the fast-drying glues, but for a really good job it should stay in the clamps for a week. Then the crack is sanded lightly with fine sandpaper, shellac is rubbed on, and the whole blade is sanded and varnished. For an emergency job, the glue may be protected by shellac alone or even with grease.

Keep this method of clamping in mind, because it may come in handy some time when you are far from home.—JACK HAZZARD.



How the clamp is made. Twisting the cord tightens the grooved pieces against the work

CASE FOR SMALL FILES TURNED FROM WOOD



The case protects files from rubbing

A CASE to keep small files from rubbing together can easily be made on a lathe. Take a piece of wood about 1¾ in. square and 6 or 7 in. long, and with brace and bit bore a 1¼-in. hole in one end to a depth of 5½ in. From another piece of the same size wood, turn the bottom as shown. It should be about 2½ in. long. Put the two pieces together, place them in the lathe, and turn down the cover until it is round and of the same diameter as the bottom. With a hand drill, bore holes in the base part to receive the tangs of your small files. A coat of shellac or varnish will protect the wood and improve the appearance. If the fit between cover and base happens to be too loose, several coats of varnish or shellac may be applied to the base and allowed to dry hard.—P. G. LACKEY and W. T. BAXTER.

A 1¼-in. hole is bored in the stock for the cover before it is turned to match the base

SIPHON-BOTTLE GAS BULBS SERVE AS TOOL HANDLES

EXCELLENT handles for small files and carving tools may be made from discarded siphon-bottle gas bulbs such as are used to prepare charged water at home. My method is to drill out the soft metal plug, fill the bulb half or three quarters full of sand, and then pour melted sealing wax level with the top. After the wax is hard, I heat the tang of the file or tool and insert it, taking care that it lines up with the handle. Sealing wax has such a low melting point that it can be melted without endangering the temper of the tool. Should a replacement be necessary, the tool may be removed by heating it at a point near the handle.—R. J. METZGER.

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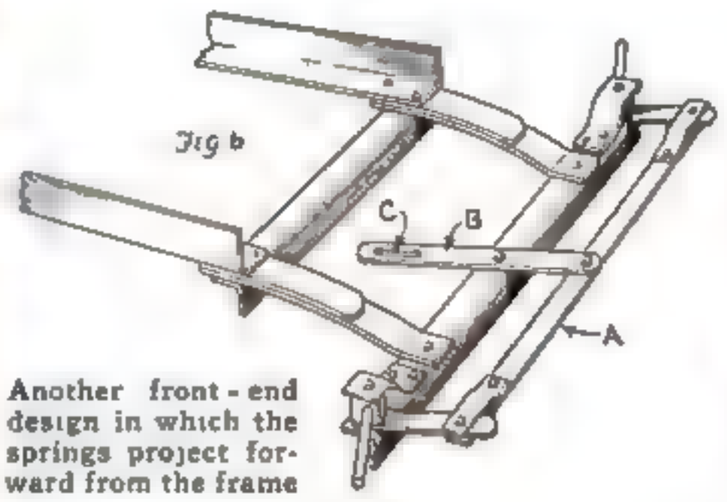
SOAP-BOX RACERS AND MIDGET AUTOS

(Continued from page 74)

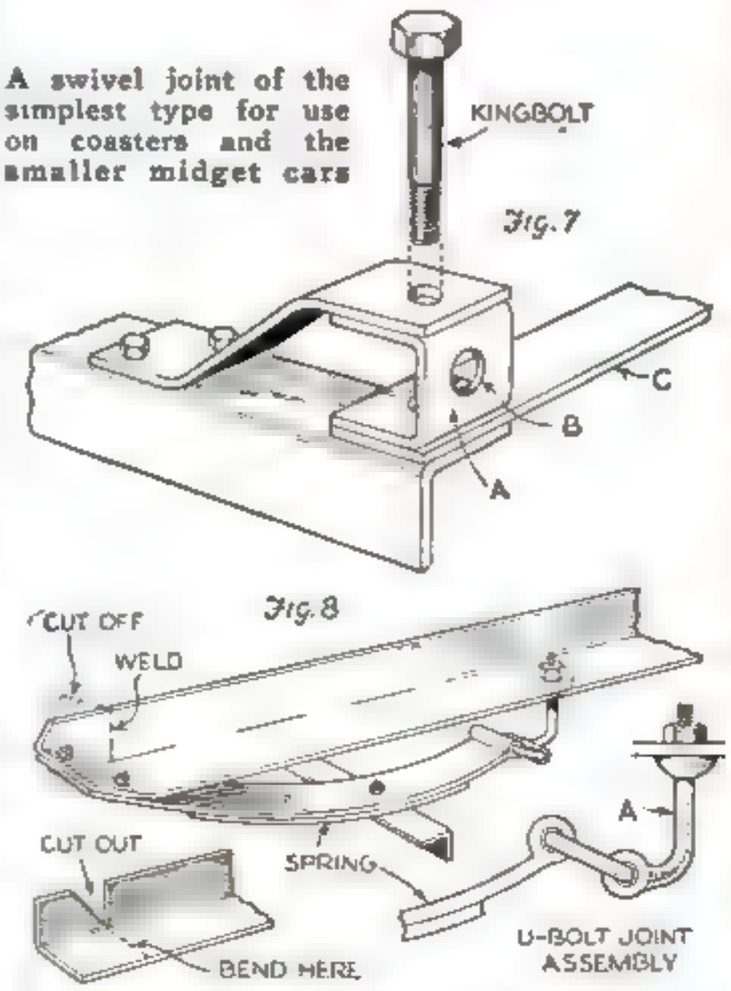
in Fig. 4. The front axle, made of angle iron, is bolted on the end of the springs. The swivel units are constructed and mounted like those in Fig. 2. The radius rod *A* is guided by the lever *B*, which in turn is controlled by the steering wheel and rod. Because of the arrangement of the springs, there will be a slight forward and backward movement of the lever *B*, and the slot *C* is therefore made long.



Another front-end design in which the springs project forward from the frame

The swivel joint shown in Fig. 7 is simple in construction and suitable for smaller midget cars. Part *A* may be cut from a length of iron that has three sides resembling a U, or a piece of steel may be cut and bent to shape. Holes are drilled for the kingbolt perpendicular to the top and bottom of the swivel. If the axle is going to be welded to the swivel, it should be fitted to the hole *B* first. The lead *C* to the radius rod is welded to the bottom of the swivel.

One of the most practical arrangements for steering control, it should be noted, may be made with the assembly from an old car.



A swivel joint of the simplest type for use on coasters and the smaller midget cars

A front end similar to Fig. 2, but with the U-bolt joint assembly from a model-T Ford

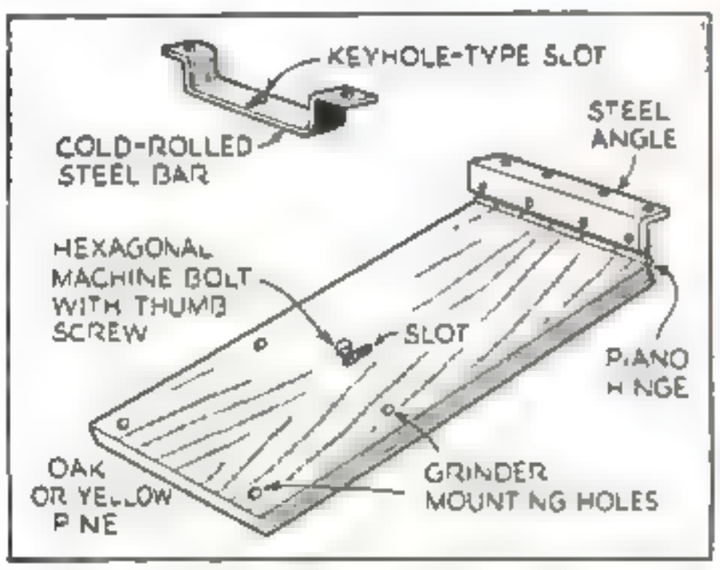
GRINDER MOUNTED UNDER BENCH TO SAVE SPACE

The tool grinder raised to operating position in front of a bench that holds a lathe

MOUNTED on a sturdy base that swings under the workbench when not in use, this grinder is always handy, yet takes up no bench space. By locating this accessory in line with a motor used for some other piece of equipment, the need for a countershaft or extra motor is eliminated.

Fasten a steel angle under the bench to support the hinged baseboard at one end. At the outer edge of the bench, underneath the top, mount a strap steel stand-off brace to hold the grinder horizontal and to provide a seat for the clamping bolt. The latter is an ordinary hexagonal machine bolt with a large wing nut. The head of the bolt must just pass through the large part of a keyhole type slot in the stand-off brace, and the threaded portion must just clear a straight slot in the baseboard.

Use a large washer between the wing nut and the underside of the baseboard. It is also a good plan to use an extra belt, leaving it on the grinder at all times, and adjusting its length so that the motor will not have to be moved.—WALTER E. STEWART.



The mounting consists of a hinged baseboard and a brace to hold it in the raised position

Except when it is in use, the grinder hangs beneath the bench, entirely out of the way

MODERN DESK CLOCK

(Continued from page 63)

the table and tilt the table to the desired angle. The cutting can be done a little faster, however, if an abrasive cut-off disk is available. In either case, set the ripping fence of the saw so that the blade will first cut the side of the groove farthest away from the fence; then move in exactly the width of the blade after each cut until the desired width of groove has been obtained. If only hand saws are available, the same procedure should be followed, the necessarily rougher work being trued up by a few strokes with a square or triangular file.

THE next step is polishing the assembled parts. First remove as much of the newspaper as can be torn free from the cemented clock face, and use a fine grade of sandpaper to remove the rest. Scrape away with a penknife all the excess cement on the face and legs. The polishing itself is done with a high-speed buffing wheel (1,400 to 1,700 r.p.m.), using powdered pumice and water mixed to a thick mudlike consistency. First hold a handful of the pumice to the revolving wheel, until it has picked up as much as it will hold; then hold the work against the underside of the wheel, moving the piece to be polished slowly across the width of the wheel and pressing as hard as possible against the wheel without slowing it up or deforming its shape. Care should be taken to apply pumice frequently to the wheel, as this will not only speed up the work but will also prevent scorching the cast-resin material.

In polishing the edges of sheets, when it is desired to get a sharp edge, hold the work at right angles to the body and directly parallel to the wheel and do not move it across the face of the wheel. If a rounded edge is desired, a slight movement across the face will give the desired result.

Follow the pumice polishing with a second buffing, this time using tripoli or other good wax on a soft muslin disk revolving at the same speed as in pumice polishing. A final buffing on a dry muslin disk will bring out the fullest possible gloss.

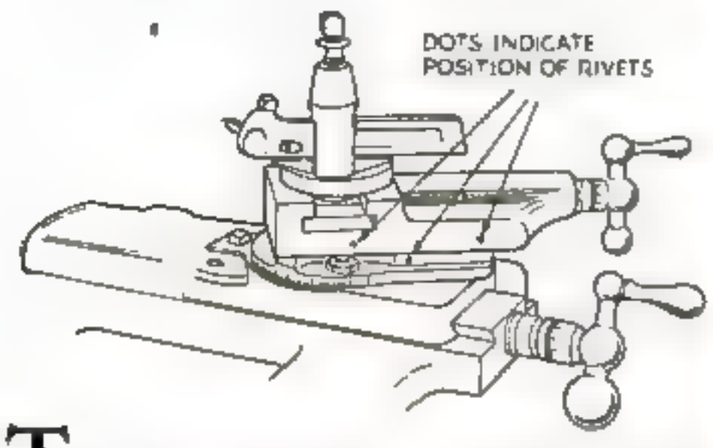
AFTER all parts are polished, cement the legs into position on the base, centering these between the front and back edges of the base or, if a large, heavy clock movement has been used, placing them slightly forward of the center line. Next attach the movement to the back of the faceplate, using small metal screws set into holes drilled halfway through the panel. It will be found that machine screws (avoid wood screws because of their taper) will cut their own threads in cast resin, but care should be taken that the holes drilled are large enough to avoid excess strains, which might otherwise crack the sheet.

The hands, which were previously removed, should now be placed back in position. If the hands are of some old-fashioned design, too ornate for so modern a clock, make new ones; or cut off part of the old ones and cement new hands, cut from thin plastic material, on the stubs. The faceplate may now be cemented into the grooves cut in the legs. In cementing the legs to the base and the faceplate to the legs, use only sufficient cement to insure a good bond and carefully wipe away any excess. Polished surfaces are less easily cemented than rough ones. It is therefore advisable to roughen the surface of the base under each leg by sanding it slightly with a coarse grade of sandpaper.

Finally, paste a sheet of dark-colored felt on the bottom of the base.

If desired, the remaining length of rod may be cut into four ¼-in. buttons to form legs supporting the base and raising it slightly off the desk or table. If legs are used, of course, no felt padding will be needed.

MARKING COMPOUND REST TO INDICATE TRAVEL



THE average operator of an engine lathe, whether in a home workshop or a factory, has probably more than once become vexed at "running out of thread" when using the compound rest. Instead of doing something about it, he is likely to reprove himself for not making a better guess as to whether or not the thread was ample for the length of the cut.

To prevent this troublesome occurrence, I drilled three shallow holes in the side of the compound, as shown. Into these I inserted three bright roundhead aluminum rivets. The one in the lower member serves as the index or zero point, while the two in the top member indicate the points of extreme travel. Thus, at a glance, you can immediately tell just where you are at and whether or not you'll need more thread to allow the tool to traverse the work.—C. RAYMOND HELFRICH.

NAUTICAL TABLE LAMP

(Continued from page 61)

six belaying pins *P* are easily turned from brass welding rod, or, as mentioned before, may be made from any metal if coated with aluminum paint.

Next, obtain a short length of rope having a diameter of 1¼ in. (circumference about 3¾ in.). Wrap it tightly with strong twine about ½ in. from one end, and trim off square with a razor blade, leaving just enough rope to prevent the twine from slipping off. Nail this end in the groove in the base so that it fits closely against the plug *M*. Now cut the rope the required length to fit around the base, and treat the other end with wrapping in the same manner. By twisting right or left as required, the length of the rope may be altered until a snug fit is obtained. Nail the ends first, then nail about every 3 in. around base, using 2½-in. finish nails with the heads set in out of sight. This rope, having a greater diameter than the thickness of the base, forms a cushion which will not scratch the surface upon which the lamp stands. Felt is therefore not required for the base.

A variety of ropes and blocks are fastened to screw eyes or belaying pins in the fife rail, the upper ends being plugged into small holes in the bevel at the top of the mast. For contrast, make the blocks of black walnut. A rope may be used to operate the switch in place of the usual chain, if desired.

The shade in the illustration was homemade and painted in oils, but an appropriate one may be bought. It should be of good quality "parchment," 7 in. in diameter at the top, 14 in. at the bottom, and with a *vertical* height of 8 in. In place of the usual binding or fancy trim, this shade has an edging of 9-thread rope (5/16 in. in diameter), sewn on with straw color silk thread hidden in the twists of the rope.

If you paint your own shade with oil colors, remember that you have two effects to consider: one when the lamp is lit, and one when it is out. White paint must be used thin; black paint, thick; and other colors in proportion. As a safety measure, frequently test your painting by holding the shade over an electric light bulb.

W. S. Rinehart, Louisville, Ky., designing an airplane theme for a college year book.

"I FIGURED OUT A WAY TO SAVE MONEY"

Gentlemen:

In my job of selling printing, I have driven my Plymouth over 47,000 miles in the last 18 months. This is a lot of traveling, and car upkeep is an item to be considered.

Therefore, I have figured out one way to save money: I selected four widely advertised oils; used each oil three times, 2,000 miles each time, a total of 6,000 miles on each oil. Two of the oils had to have four quarts added before 2,000 miles were completed. With one, I had to add two quarts.

But with Quaker State, I never used over one quart in 2,000 miles. That meant a saving of nearly fifty quarts a year as a result of this simple experiment.

All tests were made over approximately the same roads and same conditions. Average speed about 45 miles per hour when on open roads.

Sincerely yours,

W S Rinehart

"First choice of Experience"

QUAKER STATE MOTOR OILS

Retail Price . . . 35¢ per quart

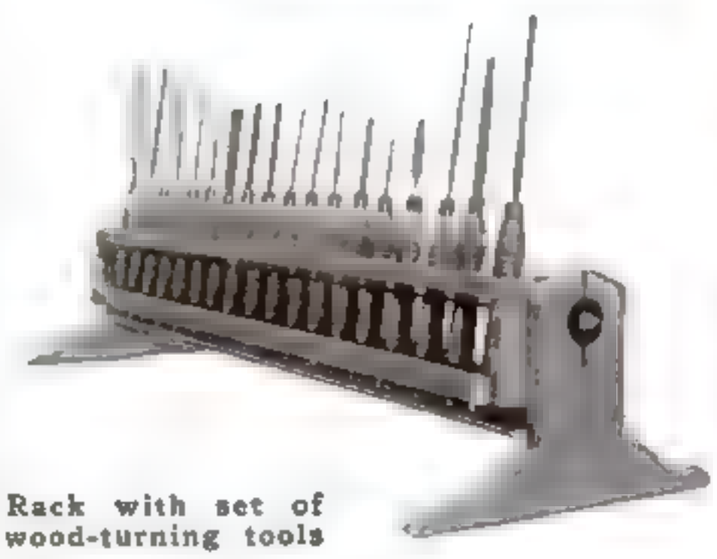
Quaker State Oil Refining Co., Oil City, Pa.

NOVELTY SPORT BUTTONS MADE FROM NUTS

BUTTONS that are especially suitable for sports clothes may be made from nuts such as the American (black) walnut and the hickory nut. All that is necessary is to clamp the nut firmly and cut it crosswise into slices of the desired thickness with a fine-toothed saw. Remove the loose bits of kernel and then sandpaper the button to remove the saw marks. Drill holes for the thread and, if desired, apply a coat of shellac or varnish to protect the surface. Several buttons can be cut from each nut.

The button illustrated was made from the black walnut.—W. T. B.

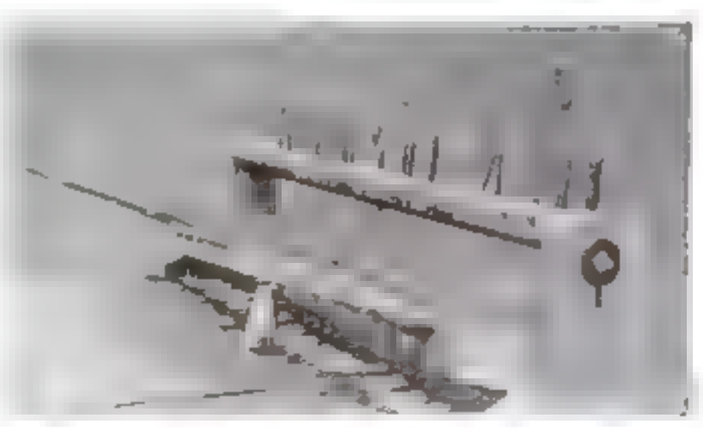
A HANDY TILTING RACK FOR TURNING TOOLS



Rack with set of wood-turning tools

DESIGNED to hold a complete set of wood-turning tools, the rack illustrated can be attached to the wall or set on the bench, just behind the lathe. Most craftsmen prefer to have their lathes placed in front of a window, in which case there is no convenient place to keep the turning tools.

This rack tilts forward to make it easier to select and remove the desired tool and later return it to its place. Therefore the tools are always in place, instead of being thrown down against one another and constantly getting covered with shavings. The rack may also be adjusted backward or forward and up or down. It holds eighteen different tools and has an auxiliary rack at rear for small tools, such as dividers, markers, drills, and extra centers.—E. L. CRUM.



The front part of the rack tilts forward to make it easier to select the required tool

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OUR NEW MODEL OF THE *GREAT REPUBLIC*

(Continued from page 75)

and draw tight with lanyards to the hearts bolted to the knightheads; then finish off with a hitch around all parts. Seize both parts together about ½ in. from the top.

For the capstays I made little wire shackles, into each of which I spliced a cord for the stay and one for the backstay, then hooked them to the eyebolts in the cap, which I left slightly open for the purpose. The cap stays go through the first holes in the bees, along the bowsprit and into holes in the bow, where they are fastened with glued pegs. They are seized together at the mast and above the jib boom.

IT SHOULD be mentioned that all the head stays in reality went through holes in the bow and were set up inboard. We cannot do this, so fasten them off with pegs. The cap backstays come down abaft the top and are set up, like a shroud, to the tenth channel deadeyes.

Reeve the topmast through the cap, put in the fid, and settle it down on the lower trestletrees. Set tight the topmast shrouds to the deadeyes in the futtock shrouds, with about 3/16 in. space between them. Proceed as for the lower shrouds with two pair each side. Give them sheer poles.

There are three backstays each side. The first pairs go on like the shrouds. The after ones I join at the top with a cut splice, but one cord with a bight seized in the middle will do. A sheer pole will extend across the four deadeyes.

The topmast stay is double, passing up between the second and third crosstrees and around the mast; the lower ends go through the bees and back to holes in the bow. The inner jib stay has a long eye spliced in it to go around the mast; the end goes through the jib boom, under the upper cleat on the martingale and back to the bow.

The topgallant mast is stepped like the topmast, but on the foreside of the latter. The two stays go on first with eyes spliced in their upper ends, the lower ends being reeved like the jib stay. The pair of shrouds on each side are seized to the masthead; the ends go through the holes in the crosstrees, around the futtock bars, and are there seized. The futtock bars are short wires seized *under* the topmast shrouds. The topgallant shrouds sometimes came to a band around the mast, but our topmasts are so short that I thought the arrangement adopted is the more likely.

There are two backstays each side, seized to the masthead and coming down to deadeyes as before described. See that you get the tension even on all, to hold the mast in line. Tighten the stays after the backstays are set up.

FROM the royal and skysail mastheads there are single stays and backstays. These backstays come down outside the outriggers, and when the model is finished they are slipped in the cleats. Their position cannot be judged from the large rigging plan, but they are shown correctly in the detail (February issue, page 73). The skysail backstays do not need deadeyes, but can be hitched to eyebolts in the channels.

The other masts should be rigged the same except for the lead of the stays. At the main and mizzen, the lower and cap stays come to hearts bolted to the deck and the others to eyebolts in the tops and caps before them.

The spanker mast has two pair of shrouds each side, rigged as at the other masts, but lighter. The topmast has one pair of shrouds to a side, seized to the eyes on the crosstrees. They are fitted with ratlines. The topgallant mast has the usual single stay and backstays.

From the fore, main and mizzen topgallant mastheads to their *(Continued on page 104)*

OUR NEW MODEL OF THE *GREAT REPUBLIC*

(Continued from page 103)

royal mastheads, there should be Jacob's ladders, seized abaft to the eyes of the rigging. Above that point the seamen had to shin up. I made these ladders of thin wire, soldered.

Before we can finally set up the head stays, the jib boom must be rigged. It is best to let this go as long as possible because it is much in the way, so I temporarily hitch the head stays around the bowsprit. Lay the inner end on its cleat and there lash it. Hook the dolphin striker in position; seize one end of a small chain to the boom at the first stop; seize the bight to the striker end; then seize the other end to the last stop. Seize the bight of another chain to the striker end; twist thimbles or rings into the ends of the chain, and with lanyards bring them tightly to the inner bolts on the catheads. Adjust the chains very tightly to hold the dolphin striker at a right angle to the jib boom. The stays can then be put under their cleats, drawn tight, and pegged off.

THE spreaders are hooked to the cap. The bight of a line is seized to the second stop; and the ends are rove through the inner eyes on the spreaders and brought back and drawn tight to the eyes on the catheads with small hearts or thimbles. This is repeated for the outer jib-boom guys, from the boom end.

When this is done, I advise tying a piece of white rag to the boom end and another halfway up the royal stay as warnings not to bump them.

At about 1⅜ in. from the deck, trucks (bullseyes) should be seized to the shrouds and backstays in an even line. The running gear reeves through these. The only ones we shall use will be for the higher fore and main braces, but they should be put on right along. I used 1/32-in. black beads and seized them on with thin thread, to lie with the holes vertical, inside the backstays.

I made no provision on the model for setting sails. She is as if prepared for a long stay in port, with all the sail gear unrove and stowed away.

The studding-sail gear, which she probably had, is also stowed below. That is what the long hatches are for.

Next month we shall be able to cross the yards and attend to the finishing touches.

HINTS ON USING FILES, SAWS, AND PLANES

THE file, handsaw, hack saw, and wood plane are four tools that are often used or misused in such a way that they quickly become dull and give inefficient service. Some men, when using a file, will apply practically the same pressure on the backstroke as on the forward stroke. This greatly hastens dulling the file, the teeth of which slant forward.

A hack saw should carry no more than its own weight on the backstroke, and only a little pressure when traveling forward. Much weight on it will not only cause it to run crooked, but often snap it in half.

A handsaw for crosscutting, when sharp—as it always should be—needs no noticeable weight upon it to cut its way through a board. A ripsaw may be "leaned on" a little on the forward stroke. But here again, if there is too much weight on it, the cut will run off to one side.

The plane should be used in somewhat the same manner as a file. Raise the heel of it slightly on the return stroke so the blade will clear the wood.—ALBERT SCHANTZ.

CLIP KEEPS RULE IN POCKET

A PENCIL clip soldered to the brass binding of a folding rule will keep it from dropping from the pocket when one bends over.—G. G.

CONSTRUCTING MARIONETTE STAGES

(Continued from page 65)

ferns, moss, mushrooms, and flowers give lovely effects. Have the stage face the setting sun so that the light will not shine in the eyes of the audience.

The sides of marionette stages should always be left open and clear for the easy entrance and exit of marionettes and their strings.

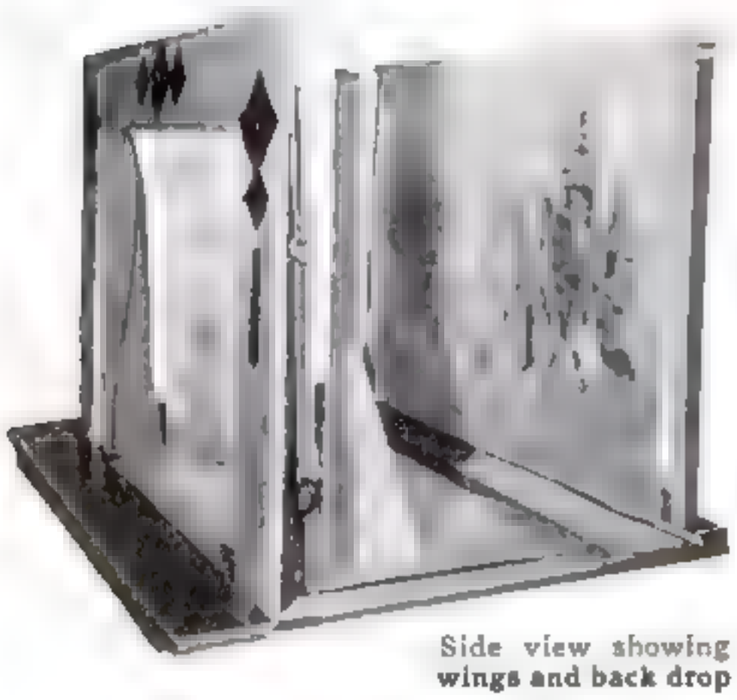
An ingenious theater devised by one of my pupils is in a hall opposite the top of a flight of stairs. The balustrade across the landing screens the legs of the puppeteers, and a valance from the ceiling hides their heads and arms. The audience, limited to between ten and sixteen, sits on the rising stairs.

Stage for doorway with decorated proscenium, curtains, wings, and painted back drop

A small stage may be easily arranged in a window—one opening upon a porch, for instance. The upper sash is curtained (or the shade pulled down), leaving the lower part with its sash raised for the stage and proscenium opening. Any table the height of the window sill will serve for the stage floor. A standing threefold screen makes a fine back drop—one not too tall for the operators to work over. A bridge lamp may be connected to give the necessary lighting effects.

Excellent stages can be made of wooden packing boxes such as large radios or refrigerators are shipped in (Fig. 8). The top is taken off and the sides knocked away, at least partially. An opening is cut from the front and then braced. Strips of wood making the back a foot or two higher should be nailed on. Another strip can be nailed to the top of these, projecting at least a foot on either side. On this is hung or placed the back drop. Any amount of finish or decoration may be added.

Every puppet theater needs a garden scene, street scene, wood scene, and interior sets. Hints on making these will be given in a following article.



Side view showing wings and back drop

ADHESIVE TAPE WILL PROTECT YOUR THUMB WHILE WHITTLING

If WHITTLING makes your thumb sore, apply a piece of dry-back or surgeon's adhesive tape to it before starting work. Another piece can be placed where the back of the knife bears on the forefinger.—P. O'N.

THE BEST SIZES TO MAKE BIRD-NESTING BOXES

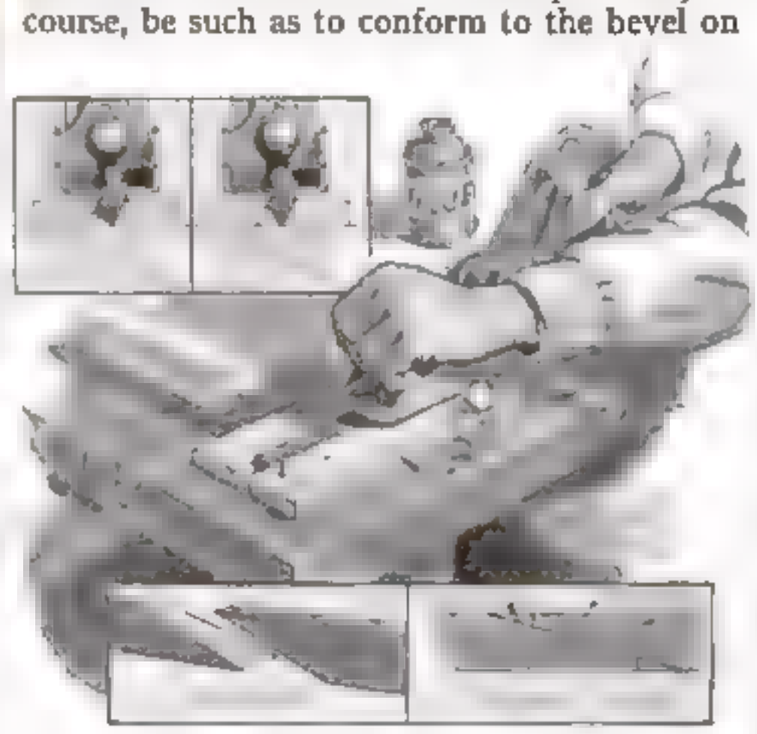
Species	Floor of cavity	Depth of cavity	Entrance above floor	Dia of entrance	Height above ground
Bluebird	5 x 5 in.	8 in.	6 in.	1½ in.	5-10 ft
Robin	6 x 8 in.	8 in.	one side open	one side open	6-15 ft.
Chickadee	4 x 4 in.	8-10 in.	6-8 in.	1⅛ in.	6-15 ft.
House wren	4 x 4 in.	6-8 in.	1-6 in.	1 in.	6-10 ft.
Barn swallow	6 x 6 in.	6 in	one side open	one side open	8-12 ft.
Flicker	7 x 7 in.	16-18 in.	14-16 in.	2½ in.	6-20 ft.
Red-headed woodpecker	6 x 6 in.	12-15 in.	9-12 in.	2 in.	12-20 ft.

NOTE: See page 70 for designs. Houses on poles are preferred to those in trees (unless suspended) because they are safer from natural enemies. The above dimensions are recommended in *Houses for Birds*, published by the U. S. Department of Agriculture.

LEATHER REMNANTS USED FOR MAKING V-BELTS

V-BELTS for home workshop use may be made, when necessary, from remnants of good leather belting bought at a junk yard. For 25 cents I purchased a long, narrow strip that was sufficient for a dozen belts.

I beveled the edges of two laths as shown, nailed one to the workbench (setting the nails), placed the strip of leather alongside the beveled edge, then placed the other lath snugly against the leather, and nailed this lath to the bench. The bevel on the strips must, of course, be such as to conform to the bevel on



How to bevel and splice a length of waste leather so it can be used with a V-pulley

the pulley on which the belt is to be used. With a block of wood I tapped the leather down against the bench to be sure it had not buckled up at any point. Then, using a sharp plane, I planed the edge of the leather, reversed it, placed it in position between the laths, and planed the other edge. Even though the leather had a somewhat crooked edge, it came out perfectly straight and uniform in width.

Splicing the belt is somewhat more difficult, but can be done with a little practice. I scarfed the ends and used one of the so-called liquid solders, although any good glue will do. Two priming coats should be put on the scarfed ends before the final gluing. To keep the ends from sliding on each other, I drove three very fine brads through, one at each end of the scarf and one in the center, then placed the joint in a clamp. The splice should be slightly thicker than the rest of the belt, as some little trimming will be necessary. It is almost impossible to find the splice, if well made.—C. A. VEBURG.

WOOD SCREW HEATED TO PREVENT SPLITTING

WHEN heated to a blue color, a wood screw can often be driven into a board that otherwise would certainly split. An extreme example is illustrated. The screw was driven while hot through the wood without first drilling a hole or making any kind of entering point.—JAMES H. BEEBEE.

TWO LATHE HINTS FOR HOME MACHINISTS

A rod, squared at the end and held in a hand drill, quickly reverses jaws of a lathe chuck

WHEN working with an independent four-jaw lathe chuck, it is often necessary to reverse the jaws. The chuck key is satisfactory for tightening and adjusting the jaws, but is very slow and tiresome for reversing them. For quick work, square the end of a 3-in. piece of drill rod, insert it in a hand drill, and use as illustrated above.

Lathe work is always somewhat oily and dirty. If you work from a magazine article and handle the magazine, you are certain to get it badly soiled. To prevent this and preserve my magazines in good condition for future reference, I keep a large clip hanging on the wall and attach the magazine, open to article I want, to that.—B. K.

Magazine hung by clip near lathe so that it will not become soiled by constant handling

STEEL BALLS SAVE TIME IN JIG-BORING JOBS

IN BORING jigs on a milling machine, the use of the graduating lines on the machine is not very practical. One hole will generally be bored at the proper location, and succeeding holes determined from the first. As the holes are bored to plug-gage size, it is necessary to keep reboring these holes and making adjustments on the table until the proper distances are obtained. The reboring of the holes is a tremendous waste of time and much of it may be eliminated by the use of an ordinary steel ball. As soon as the tool makes a perfect circle, all that is necessary for a check is to place a ball about ⅛ in. larger on the entrance of the hole and test with micrometers. A few holes checked in this way will prove the method's value.—EDWIN N. OLSON.

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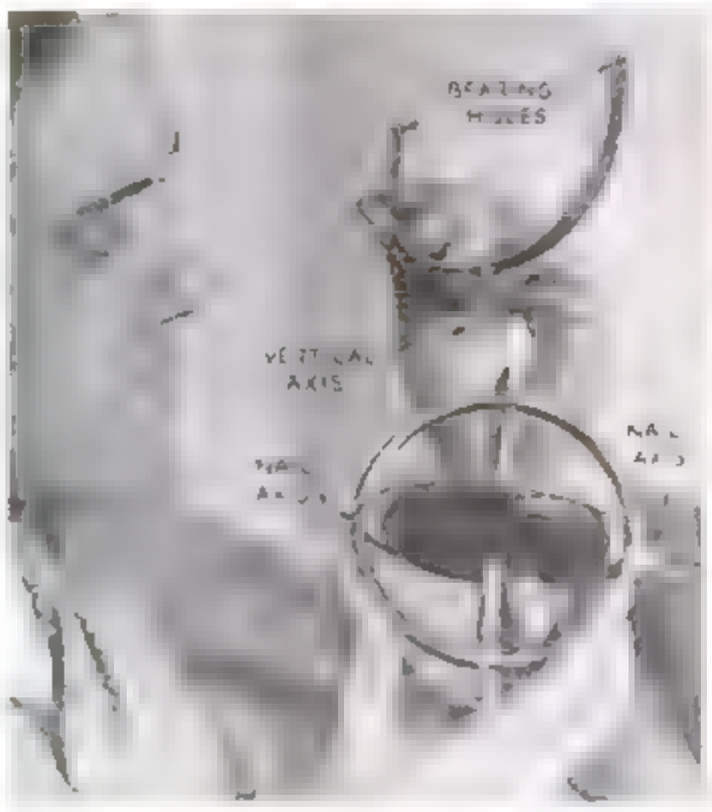
HAS THE EARTH TURNED UPSIDE DOWN?

(Continued from page 49)

In this case, I fastened the fork immovably to the top of its base by means of two small nails (see illustration). Then, after spinning the top in the direction shown by the arrow, I swung the entire apparatus, held horizontally, in an arc. At once the gyroscope turned over in a direction exactly at right angles to the direction of the external force, applied by my hands.

Now think of the gyroscope as an embryo planet, rotating in the direction of the arrow and being carried horizontally in its orbit. You can understand why it tends to tip over until its direction of spin coincides with the direction of its orbital motion.



This photograph shows the simple changes which adapt a gyroscope top for the tests

You know, after this experiment, the explanation offered by this theory of why the earth turns on its axis from west to east and also travels among the stars in its orbit from west to east. It has been beaten in its wrestle with the sun and is now standing on its head!

The earth is still putting up a show of resistance, based on this hypothesis, for its axis still has a slant of about twenty-three and one half degrees away from the vertical. In the case of Jupiter, the bout appears to be about over. The giant planet's axis now lacks only three degrees of being vertical.

The interesting question as to why Jupiter has yielded to the sun's pull more readily than the earth and Mars can only be answered by pointing out that Jupiter's great size and long-maintained plastic condition increased the gyroscopic effect, while the smaller planets cooled into a less pliable state before the process was nearly complete.

THE most interesting of all the planets (looked at as a gyroscope) is Uranus, for this planet is almost at the point where its axis is parallel to the plane of the ecliptic. Uranus, in other words, is nearly half tipped over.

In the case of Saturn, there is an interesting bit of evidence which indicates that this planet has actually turned over, as the theory of inversion requires. This is found in the motion of Saturn's ninth satellite, which revolves around the planet in a retrograde direction, opposite to the motion of all the others. The explanation of this is that the outermost satellite was condensed from an exterior ring of planetary material while the rotation of Saturn itself was still retrograde. Later, when Saturn had been turned over, the satellites nearer to the planet were formed and accordingly revolved in the direction the parent planet was then turning. The ninth satellite was, it seems, left as a souvenir of the reverse motion the planet once had.

HIDDEN MINERALS FOUND WITH NEW MAGIC EYE

(Continued from page 17)

tiny cup-shaped crater in an arc electrode, is all the instrument requires for a complete assay of any mineral, even if present only in quantities far too small to respond to ordinary chemical tests. In the sunlike heat of this arc, minerals in the rock are vaporized and write their own identifying marks in patterns of vertical bars. As little as one part in 100,000 is clearly revealed, and by an accurately calibrated system of measurement, the quantity present also may be measured.

"Fingerprinting" gold is a weird new application of this instrument. Gold, as found in nature, says Dr. Herman, contains minute quantities of silver, copper, iron, vanadium, platinum, and other minerals. This percentage varies widely, and every mine has a different combination. A microscopic bit of the gold, put into the crater of the spectrograph, reveals a spectrum pattern as unmistakable as the whorls and loops of a fingerprint.

THE thin skin of oxidized mineral on the surface of a nugget often will have a different combination of minerals from the interior of the gold. By beating the gold and removing a sample of this tissue-thin leaf, an additional check is obtained.

Not long ago, a miner was charged with the theft of gold from a certain mine. He protested his innocence, claiming that the gold he had offered for sale was from his own mine. In court, the testimony of the spectrograph was introduced. Its pattern of vertical bars, interpreted by an expert witness, "fingerprinted" the gold unmistakably as the same as samples from the complainant's mine, identifying it as stolen.

Ten times more sensitive even than the spectrograph, a still more delicate instrument is mounted in an adjoining laboratory. It is the polarigraph, a newly devised electrical machine which uses electric currents to assay minerals. Any substance to be analyzed is dissolved, if necessary, with the aid of acids or alkalies. An electric current, gradually rising in voltage, is passed through the solution and is measured by the deflected beam of an extremely sensitive galvanometer. Analysis of the galvanometer's record reveals what minerals are present, and how much of each. The curve of the voltage gives a qualitative test and the amperage curve a quantitative measurement. As little as one part in several millions may be readily detected by this method.

So rapid are the new electrical and physical tests, that nowadays, instead of having their ore samples tested for gold and silver only, prospectors often have a complete analysis made. Unsuspected values in rarer minerals frequently are thus brought to light. Recently, a man brought in a piece of rock he believed to be gold-bearing and asked for a thorough test. It contained no gold, but assayed one one-hundredth of one percent in germanium, a rare metal worth nearly $500 an ounce Since that mineral is seldom found in deposits richer than one tenth of one percent, the lucky prospector was well rewarded.

A NORTHERN mining company worked its properties for years before a thorough-going assay revealed it was throwing away valuable amounts of tungsten.

Not long ago, a California prospector brought in a sample of ore which had not responded to assays for silver and gold. The spectrograph showed it to be rich in the rare metal lanthanum. Another time, a spectrogram displayed several lines in an unexpected section of the spectrum. Analysis showed the mineral to contain commercial quantities of the rare metal cerium.

Bulky sample bags of ore no longer are necessary for the *(Continued on page 110)*

HIDDEN MINERALS FOUND WITH NEW MAGIC EYE

(Continued from page 109)

chemist to assay specimens for the rare minerals. After a windstorm had blown across Southern California not long ago, Dr. Herman swept up samples of dust from the front porch of his office. Running a small quantity of this material through delicate laboratory tests, he found that the dust, blown in from the desert, contained not only gold at the rate of three and one-half cents a ton and silver at two cents, but fifteen other minerals in varying percentages.

HE CALCULATED that among the 1,600,000 tons of dust which were estimated to have sifted over Los Angeles, were scattered 8,000 tons of commercial potassium sulphate, a fertilizer worth thirty dollars a ton; 892,800 tons of silica, used in making glass; 136,640 tons of aluminum oxide; 81,600 tons of iron oxide; 1,600 tons of titanium oxide, used in making white paint; 87,200 tons of quicklime, 59,680 tons of magnesia, 1,040 tons of manganese, 256 tons of common table salt, eighty tons of chromium, thirty-two tons of nickel, 1,600 tons of soda, and 4,000 tons of potash.

By comparing this assay with laboratory samples of silt, he determined that the bulk of the dust apparently had originated in the vicinity of a dry lake seventy-five miles to the north. As the wind raced onward, it apparently picked up sand and grit from canyons on its way, its high velocity enabling it to gather gold dust as it swept along, and spread it over the city in a golden shower.

In the assayer's laboratory or deep in a mine, these new magic-eye instruments will be serving as valuable aids to man—valuable for saving long periods of laborious and exacting effort and for ferreting out more of the natural resources which he at hand.

ARMY BOMBS VOLCANO TO DIVERT LAVA FLOW

WHEN U. S. Army aviators recently bombed Mauna Loa, Hawaiian volcano, they executed the first recorded attempt to combat such an eruption from the air, and demonstrated a new peacetime use for bombing planes. Twenty 600-pound missiles loaded with high explosives were dropped from altitudes of 3,000 to 5,000 feet in an effort to halt a lava stream advancing upon the town of Hilo and the river that furnishes its water supply. Some of the bombs were aimed at the crater from which the lava issued, with the hope of closing it and forcing the opening of a new vent that would discharge lava in a different direction. Other projectiles were exploded along the edges of the descending stream, blasting gaps in the solidified edges of the flow so that it might be diverted toward the sea. To insure the greatest effect, the bombs were adjusted to burst a moment after impact, giving them time to penetrate the lava. Plans for the aerial bombardment were worked out and put into effect by Thomas A Jaggar, Government volcanologist, who announced after a week of observations following the unique experiment that it apparently had been a success.

BRAIN TUMOR PRODUCES CHILD WITHOUT EMOTION

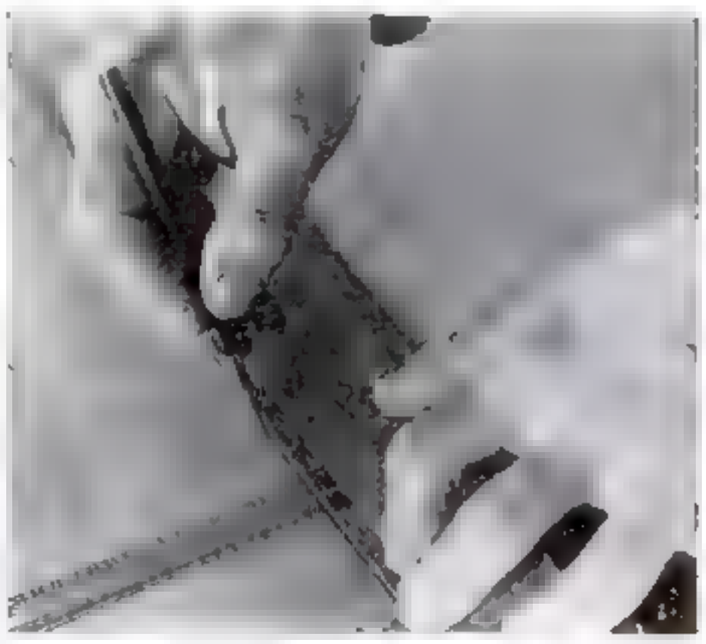
DURING the ten years of her life, an English girl who died recently never laughed, cried, expressed fear, joy, anger, or any other emotion, according to a statement by a prominent British nerve specialist. The child's intelligence was rated as normal but there was a complete absence of emotion. After her death an examination by medical scientists revealed a tumor at the base of the brain which, it is believed, had caused the strange malady.

LETTERING GUIDE LINES QUICKLY LAID OUT

T-SQUARES and triangles often become nicked on the corners. They can be repaired by filling them with ordinary celluloid cement. Trim the lumps of dried cement with a narrow chisel, and finish with two or three light strokes of a fine file guided by the edge.

Architectural draftsmen will save time in layout work if they mark off spaces on their triangles corresponding to the scale thickness of masonry and frame walls and partitions. Scratch the marks at the edges, rub them with a china-marking pencil, and clean off the surplus.

Long, thin celluloid scales that can be stretched on the drawing board or paper without interfering with T-square or triangles are found to be invaluable, once they are used. Cut a strip an inch or less in width and of the length desired from automobile-curtain celluloid, and lay it off by comparison with an ordinary scale. Stretch it with thumb tacks and scratch the marks square with the edges, afterward treating them with a grease pencil as suggested above.



Drawing guide lines for lettering with the aid of a celluloid scale tacked on the board

Where direct scaling from drawings is not to be practiced, and especially in drawings made for reproduction by photo-engraving, scales of great variety can be made by the use of a clock wheel. Stretch the celluloid strip on the drawing board, select a clock gear with fine teeth, and run it along the center of the strip, using the fingers as bearings and exerting a fairly heavy pressure. An imprint of accurately spaced crosswise dashes results, which can be made plainly visible with the grease pencil. If figures are added, they may be scratched backwards, so that the scratched side of the scale may be laid against the paper, eliminating error due to the thickness of the celluloid.

One edge of such a scale may be used for spacing lettering guide lines. In practice, the scale is thumb tacked along the left margin of the paper. To make things come out even with this fixed scale, a system must be devised to include titles and explanatory lettering. I have found it satisfactory to allot for titles a regular space plus a spacing division. Explanatory matter is then put below it, skipping one wide plus one narrow space. New paragraphs in long explanations are separated from previous material by two narrow spaces with a single wide space between.—Edwin M. Love.

SOLDERING PASTE IN TUBES

Old tooth-paste tubes make very handy soldering paste containers. Cut off the crimped end and clean out the tube thoroughly. After filling it with paste, close the open end by folding over and crimping in a vise.—J. Petr.

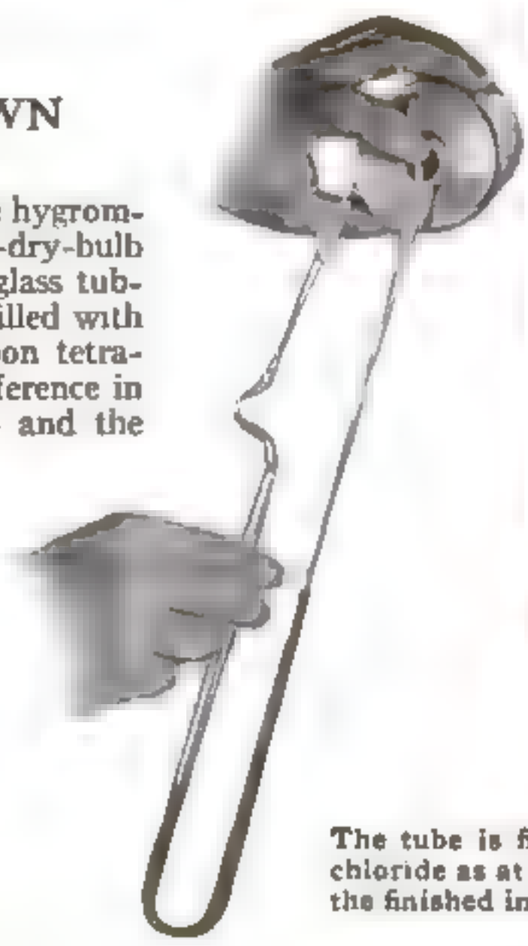
SIMPLY MADE

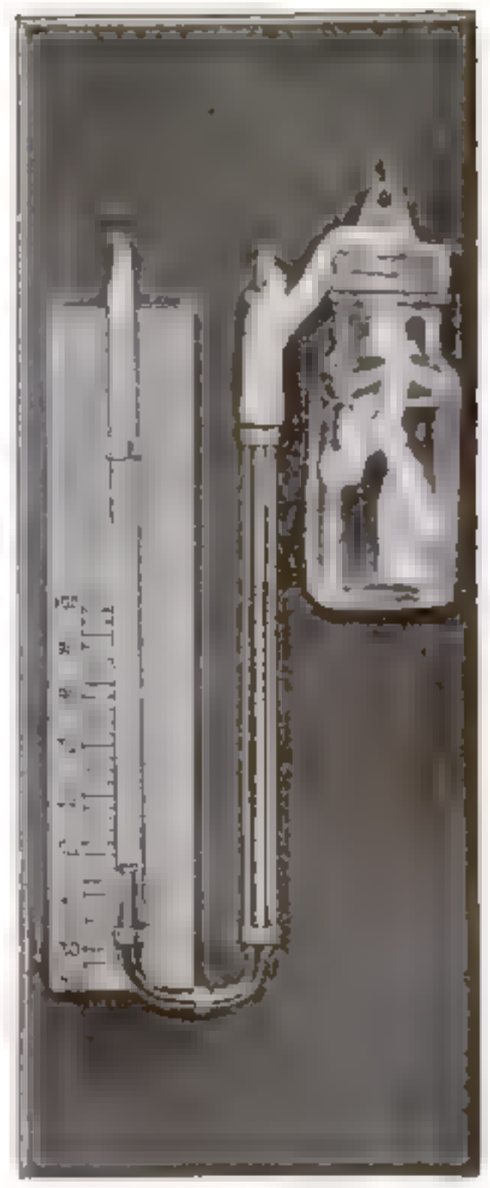
Hygrometer

Gives Direct Moisture Reading

By

WILLIAM E. BROWN





The tube is filled with colored carbon tetrachloride as at left. The height of the liquid in the finished instrument indicates the humidity

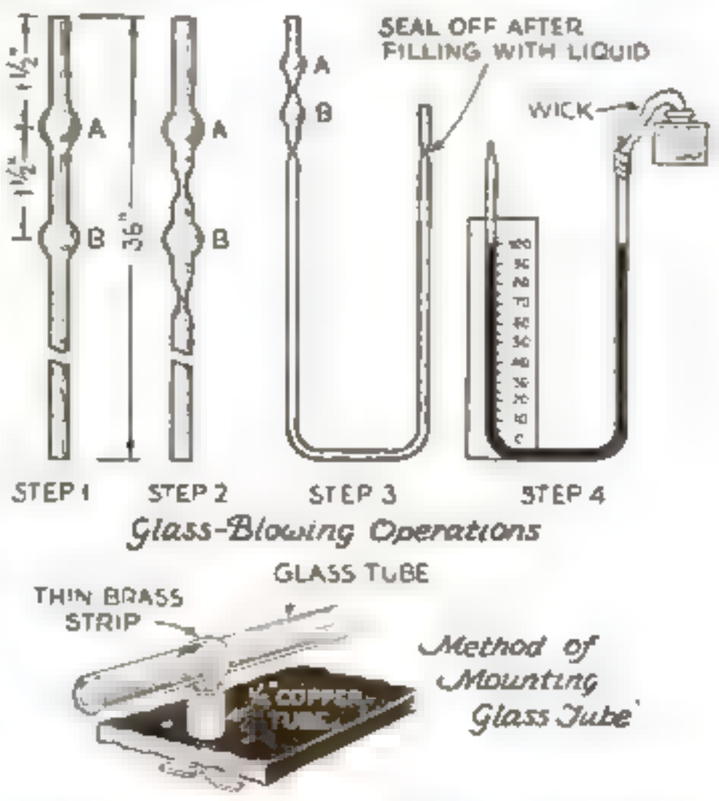
A SENSITIVE yet simple hygrometer of the wet-and-dry-bulb type can be made of glass tubing bent into a U-shape and filled with a volatile liquid such as carbon tetrachloride. In operation, the difference in temperature of the wet bulb and the dry bulb causes a difference in vapor pressure as indicated by the unequal height of liquid in the two arms of the U-tube. The drier the atmosphere, the higher the column of liquid rises in the wet-bulb leg.

Obtain a 3-ft. section of glass tubing having a bore of from 3/16 to ½ in. The smaller sized tubing is easier to handle, and little difference in operation will be noticed. Clean the tube thoroughly and blow two small bulbs 1½ or 2 in. apart and as near one end as convenient. Melt the glass down to about the size of a match between the first and second bulb and also between the bulbs and the long part of the tube. These are to aid later in sealing off the excess air in the tube. Bend the remainder of the tube at the middle so as to form a U-shape with two arms of approximately equal length.

Fill the tube to within an inch or so of the top of the plain arm with carbon tetrachloride colored with a few crystals of iodine.

Seal the top of the plain arm by directing the flame downward. Hold a finger over the open end of the tube and invert the tube to drive out the bubble of air at the closed end. Slowly boil out the liquid until enough is left to fill one arm completely. This can be done either by immersing the tube in a pail of hot water or by direct flame.

While the liquid is slowly boiling up through the capillary tube and the bulbs, melt off the first bulb, being sure not to let any air get back into the U-tube. Chill the second bulb while the U-tube is still warm. This should cause the liquid to condense or boil into the bulb, carrying the last trace of air with it. When this has progressed for a minute or two and some of the liquid has collected in the bulb, seal off this bulb and discard it.



Glass-Blowing Operations

Method of Mounting Glass Tube

Diagrams of the four chief steps in making the hygrometer, and how the tube is mounted

To test the U-tube for sensitivity, warm the liquid at the surface in one leg by applying the hand. This should force the liquid up into the other, cooler side. A temperature difference of 10 deg. between the two sides of the U-tube should make a change of several inches in the height of the two columns of liquid.

Allow enough space on the mounting board for the U-tube and the water reservoir, which can be made from a test tube or a small ink bottle. Heat the test tube, if used, 1 in. from the mouth and bend the neck into a letter J. This will make a good siphon reservoir.

Mount the U-tube with stand-off supports made of ¼-in. copper or fiber tubing cut in ½-in. lengths, with a ⅛-in. brass strip looped through and around the glass as shown. Bring the two ends of the strip through the mounting board and bend the ends flat against the back.

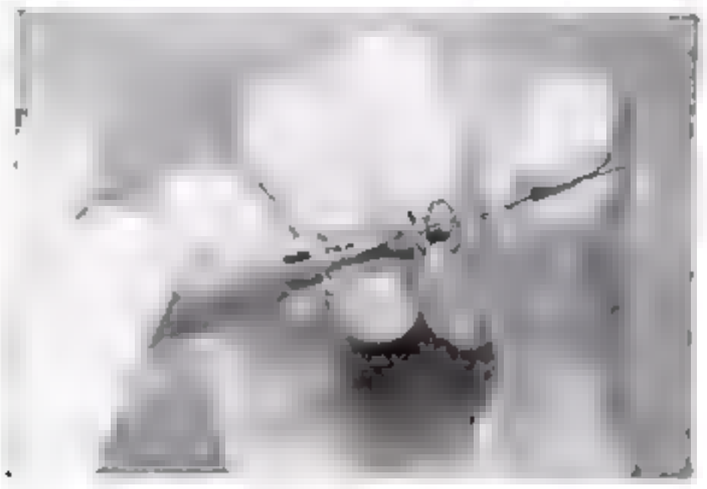
Mount the water reservoir with its mouth about ½ in. from the top of one arm of the U-tube. The wick should cover about 1 in. of the top of the nearer U-tube arm and extend to the bottom of the reservoir. Linen or cotton cloth boiled in sal soda and thoroughly rinsed makes good wicking.

Rule the scale in tenths of an inch on plain white cardboard, with 100 percent marked at the top. Place the 100 percent mark behind the dry arm, opposite the point where the two columns of liquid are the same height. With some ⅛-in. brass strips, bend a little collar that will slide up and down the dry arm of the tube to mark the level last observed.

When the water on the wet arm starts to evaporate, it will cool the vapor in the tube and draw the liquid in it up, while the other side goes down. When it is going to rain, evaporation slows down and the two columns of liquid nearly balance.

This instrument can be calibrated against a regular wet-and-dry-bulb thermometer-hygrometer by referring to the table for calculations. However, its chief advantage is that it can be read directly without reference to changes in temperature.

SAFETY-RAZOR HOLDERS MAKE USEFUL TOOLS



An old razor handle converted into a pin vise

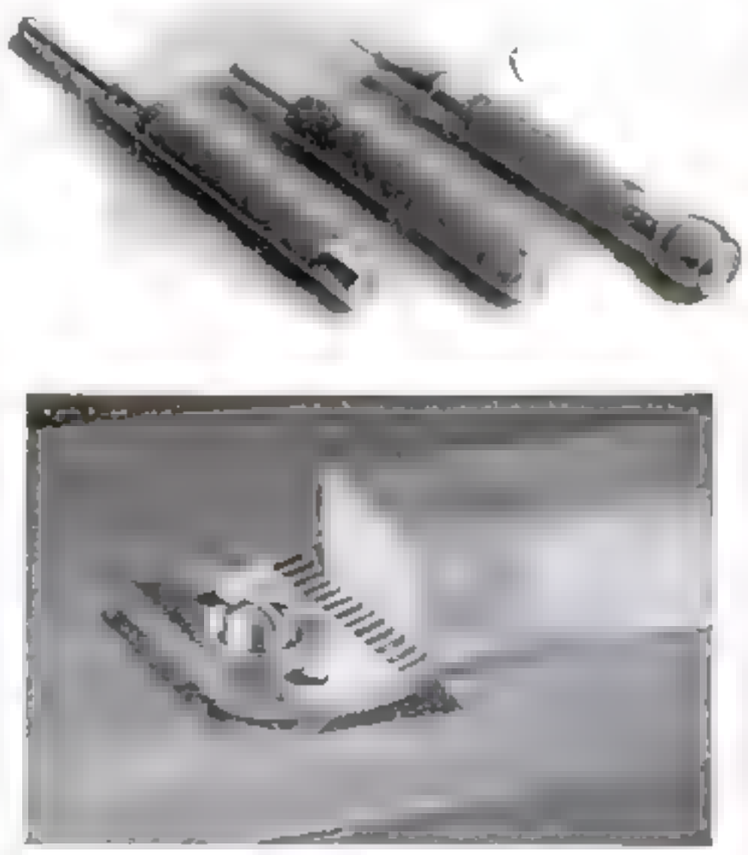
EVERY one knows of the many uses to which old safety-razor blades may be put, but discarded holders also are valuable.

The pin vise shown above was made from the handle of a wafer-blade type of razor and a 10-32 flathead machine screw. The top of the screw was built up with solder, a No. 75 hole drilled through the center of the screw, and the screw then divided into four segments by two hack-saw slits extending to within 1/16 in. of the end.

A tool for withdrawing stubborn thumb tacks and for use as a light hammer, such as is occasionally needed on the drafting table, may be made from the top plate and handle of the razor as in the second photograph.

The three tools shown grouped together are made from the handles only. Two are soft drift punches, which were made by cutting off the threaded ends of the handle. The third tool is a scriber made by soldering in a phonograph needle.

The bench stop in the last photograph is a guard and handle. The ball end of the handle was cut off and a hole drilled in the bench top to receive it. The guard was inverted as shown and held in place on the handle with a 10-32 machine screw. A recess large enough for the guard to drop below the bench top was cut out to receive it when the stop is not in use.—DANIEL REYNOLDS.



A thumb-tack "persuader" (upper photo), two drift punches and scriber, and a bench stop

MORE $5 PRIZE WINNERS

Three prize winning letters in POPULAR SCIENCE MONTHLY'S new Secrets of Success contest—*"What Home Study Has Meant to Me"*—are printed below. Read these stories carefully because your own career may be just as interesting and inspiring to other readers. If you think so, put it down on paper and send it in. We will pay $5 for every letter we publish.

Contest Rules

Only letters from bonafide home study school students will be considered and these must contain the name of the school and the name of the company, or companies, for whom you have worked since graduation. (Names, however, will be deleted from the letters when published.) We also want to know the kind of course you took and the type of position you have held. Your own identity will be kept anonymous, if desired.

We are interested in facts, not literary ability, but please write clearly, completely, and keep your letter within 500 words. We are not looking for "get-rich-quick" stories or freak adventures, and authors must be prepared to substantiate the truth of the statements. Manuscripts submitted and printed become the property of this magazine, and we are not responsible for the return of rejected stories unless sufficient postage is provided for this purpose. Address your contribution to Success Story Department, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, N. Y.

HE HAD THE URGE TO WRITE

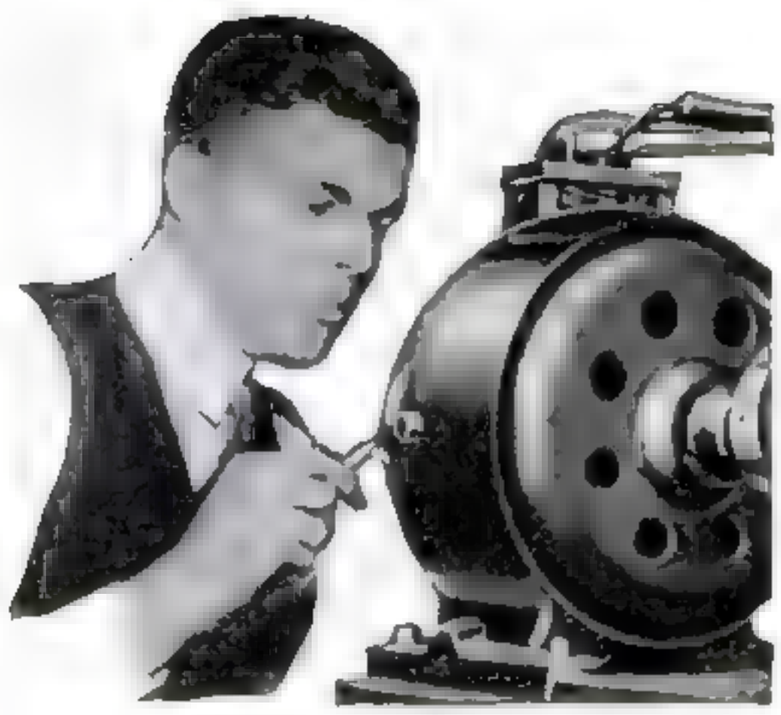
At eighteen, I graduated from high school, untrained to fill any position. I could hold down a job as a clerk, bus boy, dish washer, bootblack or office boy . . . if there had been one. But these jobs were well filled. Nowhere was there an opening.

Like thousands of others I had the urge to write. Write what? Anything. Anything that would sell and bring in some sort of income. But how to go about it? Where to begin?

Three years I spent industriously studying the writers' magazines and aping published material. Results were practically nil. During those three years I managed to sell six articles for a total of seventeen dollars! I lived with my parents then so I had few expenses, but the family needed money. A job in a grocery store helped a bit and then I drove a delivery truck.

Had I then reached the height of my success? Nothing offered any promise or hope. I still had the urge to write; I still felt that I could sell material if I knew more about it. But where was I to learn more about it? How could I learn the commercial side as well as the writing end of it?

A HOME-STUDY COURSE! Why not? I had nothing *(Continued on page 116)*



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H. C. Lewis

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The great Coyne Shops are famous the world over for their unusual **Learn-by-Doing** method of practical, individual instruction. There is no book study, no reciting—you learn quickly and thoroughly by doing actual jobs under the personal guidance of trained instructors, on a great outlay of machinery and equipment assembled strictly for training purposes. That is why, in 12 short weeks, we are able to take fellows **without previous experience or a lot of book learning,** and train them for jobs leading to good pay.

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SUBSTATION OPERATOR
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Trained men are needed in these rapidly expanding fields—the fastest growing industries in America today. Right now I'm including instruction in **Diesel Engines,** Electric Refrigeration and Air Conditioning **at no extra cost.**

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"I owe my electrical success to your 12-week shop course," says R. B. Umbarger of Tennessee. "Two weeks after leaving school I took a wiring job," reports E. O. Berndt of Illinois, "and the profits from this one job alone more than paid for the entire course." A. C. Hoehnle of Ohio says, "Received several raises in pay, due to the training I received at Coyne." And I could quote from hundreds of similar letters from successful Coyne-trained men. **What they have done, you should be able to do!**

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Secrets of Success

(Continued from page 114)

to lose. Perhaps there was something in it. I investigated the offers of various writing concerns and home study courses, and selected the one which I felt held out the greatest possibilities.

I followed instructions to the letter. I received individual attention by mail and very definite help. For the first time, I began to know what I was doing and why I was doing it. I began to appreciate the full potentialities of writing. New angles were opened up to me which had never occurred before.

For example, I never thought of writing anything but stories. Yet this school showed me the possibilities of journalistic photography, juvenile articles, science articles, poetry, farm and home articles, syndicate material and contests. Here was my entry into the writing world!

That course cost me less than a hundred dollars and it has paid for itself innumerable times over. Because of that course, I am selling almost all the material I write. Because of it, I know definitely what I may expect in the near future.

The home-study writing course has given me a regular, assured income every week. I am my own boss, and follow my own inclinations for working. There is no overseer to tell me when to work or how to work.

I am completely independent and the future — the near future — holds much promise. Through the experience gained in that writing course, I have a definitely plotted road of progress stretching straight before me.

I never did believe much in home study-courses. But, and in spite of myself, I am convinced of its value. If not for it, I might still be driving a truck!—*L. T., Cleveland, Ohio.*

LIFE-TIME STUDENT KEEPS MIND ALERT

Thirty years ago I enrolled for my first correspondence work—two majors in foreign languages—from a midwest university, and today finds me still engaged in it—at present, a course in short-story writing under an author in the Far West.

During these years I have had other courses in foreign languages from the university and am planning to take still more. I have completed a course in boys' work from an Eastern university, one in short-story writing from a private school in the East, another in accounting from a business college in Chicago.

Along with these I have had private music lessons for several years under the direction of the head of the music department of our college here. My interests in life are varied and so my home study has been varied, also.

Not only have these courses helped me professionally, but they have broadened my mind, taken up time at night that might have been a drag, and taught me to master difficulties that come up in life. In home study I have had to solve all kinds of problems and have learned to depend upon myself. One was to keep at work without personal contact with an instructor.

Secrets of Success

One really gets more from a home study course than the same work in residence study for, in a way, one knows the teachers better on account of the notes and letters from them, and must recite the entire lesson instead of only part of it. To me, home study has been a joy, partly because I can select the subject I desire, and I plan to carry it on throughout the rest of my life.—*C. H., Charleston, Illinois.*

NOW HAS HIS OWN ORCHESTRA

When I decided upon a musical education, the instrument which appealed to me most was the violin. There were several good teachers in my town, but I could not afford them, and I knew that if I waited I would never get anywhere. The question was: "What to do?"

Just about that time I saw the advertisement of the ——— School which offered instruction by mail. Not only that; it was at a price that I *could* afford. I decided to take it.

From the start, I knew I was on the right track, but before I go any further I do not want the readers of POPULAR SCIENCE to think that I became an artist over night. As everyone knows, the violin is a very difficult instrument. I had to practice and study very hard.

However, in a little more than a year I was hired to play in our local motion picture theatre but, shortly afterward, talking picture equipment was installed which threw all of us in the orchestra out of work. Fortunately, I had made many musical friends and got a job playing with a dance band which kept me busy almost every night for two years.

Then I was taken ill and had to give up orchestra work for nearly a year. I did not let my music down, however, for while I was laid up I composed several musical numbers (one of which was copyrighted) and after I recovered, I started to play again.

What's more I got just exactly the job I needed . . . with another dance orchestra. I have played in most every type of musical unit, including a philharmonic society of 110 pieces which has broadcast over the radio. I now have my own band and a stage show.—*R. W., Hudson, N. Y.*

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Time is money, and there is no reason why you can't turn a few hours of your spare time into real hard cash. It's easy, acting as our local representative in your territory. At the new low price of $1.50 per year Popular Science Monthly sells on sight—and you get a liberal cash commission for every order you take. Complete supplies and instructions will be sent free. Just send your name and address to

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Decorative plaster-of-Paris medallion of heraldic design. Many such ornaments can be cast in a single plaster mold

By

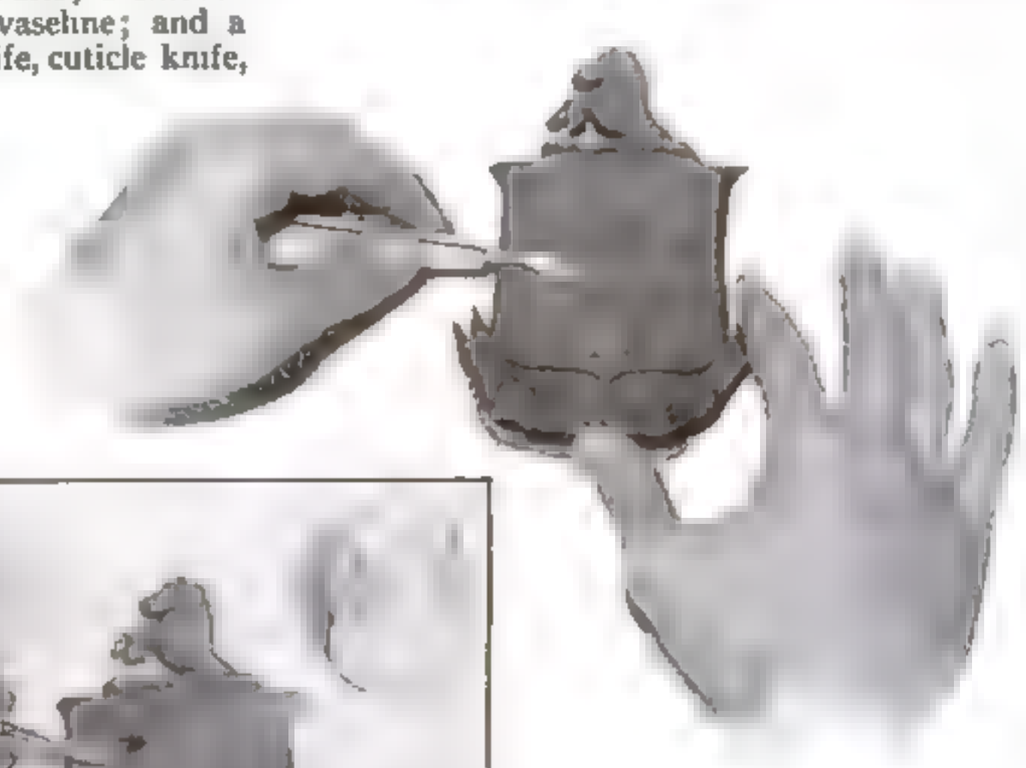
C. L. NEWCOMB, JR. *and* M. W. GIRARD

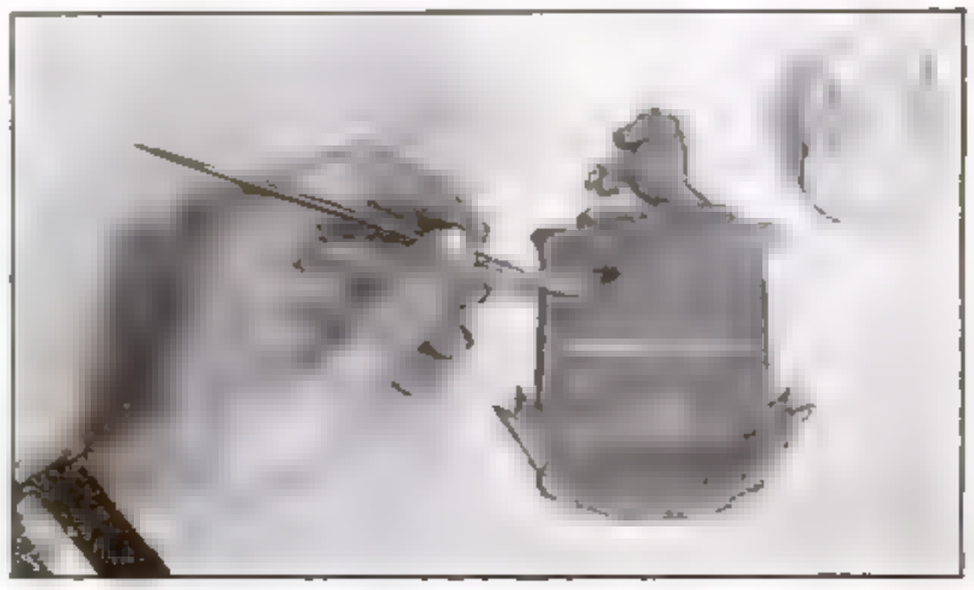
MAKING decorative plaster casts is a hobby that is not only interesting, but can easily be made profitable. There is a market for the finished product, and a good chance for profit because the actual cost of each article is low. Among the projects that can be made are coats of arms, medallions, book ends, and wall plaques of many designs.

The equipment you'll need is as follows: 1 lb. or more of nonhardening modeling clay, generally called plastine or plasticine; 1 lb. dental or casting plaster of Paris; 1 smooth board 12 by 12 in.; 1 jar vaseline; and a camel's-hair brush, palette knife, cuticle knife, orange stick, mixing bowl, and tablespoon.

A sketch of the coat of arms, or other article to be made, must first be drawn, preferably the size desired for the finished product. Then spread about ½ lb. of the clay over a smooth board in a perfectly smooth layer about ⅜ in. thick. The edges should be trimmed to form the shape desired, such as a square, rectangle, circle, oval, or shield, according to the general dimensions of the piece to be made.

Using the orange stick (or a pencil), draw every line of the design on the surface of the clay very lightly. Use the cuticle knife to cut this design out, holding the knife at an angle of about 50 deg. so that the edge slants *away* from the design. This is important in order to eliminate any drag when





The original design is made from modeling clay by a method that is partly carving and partly modeling. The model is then given a smooth, thin coating of vaseline to prevent the plaster from sticking to it

the cast is made, as will be explained later. Only cut a small piece at a time as the clay has a tendency to tear if too large a piece is cut.

There will be several places that will have to be built up or cut down according to the design. For example, if there is a fess or bar across the shield in a coat of arms, it should be cut out of another strip of clay about ⅛ in. thick and placed on the shield in the desired position. In the same manner stars, roses, lions, fleurs-de-lis, and the like must be cut out separately and placed on the shield. In the crest (meaning everything above the shield), the helmet with its crest and mantling should be so carved as to represent one half the article as worn in real life. In some cases it will be a front view and in others, a side view. This is also true in the case of animals, birds, or other figures, whether used in the crest, in the shield, or as supporters on each side of the shield. Heraldic animals and birds should be made as nearly lifelike as possible without losing the artistic effect. Many heraldic beasts and

A wall of clay is set up around the model, and thin plaster poured in to make the mold

birds, however, have to be distorted or modified to conform to the design by placing an animal's legs in an unnatural position or lengthening the tails of animals or wings of birds.

If there is a motto with the arms, the scroll in which it is inscribed should be carved so as to look wavy, as it would if it were a piece of ribbon.

When the clay model has been cut out, it should be made perfectly smooth all over. The simplest way to do this is to moisten the finger tip and run it lightly over the surface. When it is smooth, take a camel's-hair brush and paint the entire piece with vaseline, being careful to see that the vaseline also is smooth and covers the entire surface as well as a good portion of the board. This is to prevent the plaster of Paris from sticking to the model. Now a wall about ¼ in. thick and 1½ in. high must be set up around the whole model. This can be made of clay. Leave about ¾ in. between the model and the wall. Paint the inside of the wall with vaseline.

Put about 5 oz. of plaster of Paris into a bowl and add enough water to give a consistency like gruel—just thin enough to pour out of the spoon. This mixture should be stirred until the plaster of Paris and the water are thoroughly mixed and there are no lumps. Pour this into the mold, using the spoon and letting the mixture drip off rather slowly. *(Continued on page 120)*

PLASTER ORNAMENTS

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The plaster mold. The finger notches are filled with wax before making the final cast

It is best to start in one corner and gradually work away from it, as this will force all air ahead and therefore prevent bubbles from forming underneath. Be sure the mixture gets into every crevice by gently working it with the back of the spoon.

When the entire surface has been covered, fill the rest of the mold to within about ½ in. of the top. In case you have not mixed enough plaster of Paris the first time, you can mix another batch, being careful not to wait too long. Clean the mixing bowl and spoon with running water as soon as possible.

Depending on the size of the model, it will take up to an hour for the cast to become hard enough to remove. When it has thoroughly set, remove the clay wall. To separate the cast from the model, first take hold of the cast and work it back and forth gently. This will help loosen it. Now take hold of it in two places firmly and pull *straight upward.*

When the cast is free, take the cuticle knife and trim off all rough spots while the plaster of Paris is still damp.

This intaglio or mold is allowed to dry. The best way to do this is to place it in the sun. The drying can also be done in a very slow oven, but this takes longer.

When it is finally dry and perfectly smooth, cut two notches in each side and one in each end, using the cuticle knife. Now place the cast on the board again and build a wall around it as before. The wall should rise about ½ in. above the top of the cast.

Take a lighted candle and drip wax into the notches. When the next cast is made, this wax is removed, and the notches become finger grips to enable you to separate the casts. Paint all surfaces of the intaglio, including the waxed notches, with vaseline. Now mix the plaster of Paris and proceed as before, filling the mold right up to the top. In about an hour, the clay wall may be removed and the wax taken out of the notches. Then take the cuticle knife and run it around between the two casts to loosen them a bit. Separate the two, using a firm and steady pull, straight up. If all drag was eliminated in the original model, this will be easy

The final cast just made is the bas-relief. It should be trimmed and smoothed with the cuticle knife and very fine sandpaper.

If it is desired to hang the bas-relief on a wall, a wire hanger should be set in the center of the back near the top, just after the plaster of Paris has been poured.

These make attractive ornaments when colored. This may be done by giving the cast about four coats of shellac and then painting it with the desired colors in enamel.

MONEY MAGIC RESTORES MUTILATED CURRENCY

(Continued from page 28)

jelly jars, tool chests, baby cribs, and discarded tin cans. At the top of the list, however, come stoves and furnaces!

Consequently, money that has been burned accidentally forms a large part of that sent to the Washington laboratory. As much as $200,000 worth is redeemed in a single year.

In 1932, an Iowa school teacher was lucky enough to withdraw her entire savings from the local bank just before it failed. But she was so imprudent as to hide the box containing the tightly rolled bills in the back of the furnace at the home where she was staying. One day, while she was away, a fire was started in the furnace. By the time she reached home, only charred paper remained of her savings. Taking a train for Washington, she brought the blackened rolls to Miss Sherfy. Within a week, every bill had been identified and redeemed.

A DOZEN times a year, this tragedy of savings burned by accident brings ashes or blackened bills to Washington. Frequently, the loss can be recovered in whole or in part. But sometimes, not a trace of the money can be found.

Such was the case, recently, when a woman in East St. Louis, Ill., burned $3,500 while destroying trash. Later, she gathered up what she thought were the ashes of the money and carried them to Washington.

The instant Miss Sherfy looked at the charred bits of paper, she knew there was no money present. All the ashes were gray-black and glossy—obviously, the remains of ordinary paper. Currency, no matter how badly scorched, is deep black and dull-looking, with a thick body that holds together remarkably well.

Not infrequently, robbers add to the work of the Treasury experts. Their acetylene torches and explosives burn and tear bills when they cut or blast their way into safes. This currency is left behind and banks send it in to salvage what they can of their losses.

The largest amount of burned currency ever to come to the laboratory at one time arrived in 1924. A disastrous fire had swept through the town of Astoria, Ore. Eighteen safe-deposit boxes taken from the Astoria bank were rushed to Washington. Records showed the boxes contained $100,000. Working overtime, the laboratory experts identified not only the $100,000 but $20,000 more.

The source of the extra $20,000 was a mystery until it was traced to a bootlegger who was hiding this sum in his safe-deposit box.

OUT of her wealth of experience, Miss Sherfy offers the following simple rules for those who send in burned or mutilated money and for those who wish to keep their currency from being destroyed.

In case you need to hide money temporarily, place it in a metal container with a closed lid. Even in a bad fire, bills packed tightly in a closed tin box will remain as charred material which usually can be redeemed. When wrapped in paper or packed loosely, however, the money disintegrates into ashes which are easily lost or blown away.

In handling burned or rotted currency, touch it as little as possible. If the damaged money is folded or in rolls, don't attempt to unwrap it. Simply place it in a box carefully padded with cotton batting and forward it to the Treasury laboratory. If there are damaged coins present, be sure to separate them from the bills. Otherwise, they will crumble the paper during shipment and may make identification impossible.

But the safest plan, she says, is never to hide large sums in the house. They are too likely to be lost, stolen, thrown out, or burned as trash.

TRAINING SUPERPILOTS UNDER THE HOOD

(Continued from page 32)

under 200 feet, I'm so busy I don't have time to worry about crashing. It's just a question of slowing the plane down to landing speed, keeping your eyes and mind on the centering instrument and the air-speed meter, and flying in."

These boys go through some weird experiences. One suddenly feels himself glued to his seat. The instructor either has put the ship into a vertical bank, winding her up tight, or is pulling sharply out of a steep dive. Gravity or centrifugal force, or a combination of the two, has forced the student's feet hard against the pedals. Only with considerable force can he lift his hands from throttle or stick. Must he recover from a left or a right spin, or from a pull-up?

FIRST, if he has heeded the oft-repeated instructions, he looks quickly over his instruments. If they tell him he's losing altitude at the rate of several thousand feet a minute, he pulls back on the stick and centers the rudder. The rate-of-climb indicator slowly comes back to zero.

"Funny," said a student whose trim little training plane I had seen rolling and diving only a few minutes earlier, "I just pulled out of a spin. Felt exactly like I was still spinning, even when the turn and rate-of-climb indicators showed I was flying level. I couldn't believe my senses, but Gregg assured me I had leveled off. Boy, that convinced me my instruments are O. K."

But the making of a modern air-line pilot is not confined to tumbling around in these small planes, I soon observed, as I flew with a class in the trimotored class room. One student piloted the craft; a second hung out of a window, sighting the sun through an octant to figure position; a third checked wind drift through an indicator fixed to the window sill; others mapped the course while we flew a definite compass heading, and the remaining student pointed a camera through a hole in the floor and took photographs.

There is a reason for each job. The pilot must maintain an even keel along the course, with no alibi. Pictures taken at frequent intervals reveal later whether he flew a straight and level course. Nor are all these trips short hops around the field. Sometimes, a dozen students climb aboard the large ship and conduct their studies while flying from Oakland to Chicago or some other eastern city.

ALL this, because air-line flying is changing rapidly. The young men who will captain the great ships of the air now being planned are becoming navigators who will guide their cargoes across continents and oceans with a precision and accuracy unknown to the old-timers.

Tomorrow's planes will be designed for skillful navigating by just such pilots as these. In fact, there is now being built a large land transport whose pilots' cabin measures seven feet from instrument panel to pilot's seat. In that large room will be installed, for the first time in an airplane, a swiveled chart table. While the copilot flies the ship, the chief pilot will keep a continuous record of each flight, giving the copilot course corrections from time to time, ever practicing in good weather for those blind days and nights when he must plot his course and fly by celestial navigation, compass, and radio.

These youngsters are training to fly planes already being planned which will be two or three times as large as present equipment—great ships rivaling railway accommodations in luxury and comfort, and capable of cruising well above 200 miles an hour. They will follow the voice of radio through storm and fog to safe landings.

ZOO HOSPITAL KEEPS RARE ANIMALS HEALTHY

(Continued from page 47)

hinged, molded sheet of tin which closes around a porcupine to protect the examining doctor from the animal's sharp quills. The metal tube has a handle so that the porcupine can be carried around safely with only his head and the tip of his tail sticking out.

Novel devices of this kind have to be constructed to meet particular occasions. Not long ago, a small monkey with a broken arm had to be kept from picking the bandages with his teeth. This problem was solved by locking a light, hinged collar of wood around his neck; the sad-faced simian looked as though he had stuck his head through the middle of a good-sized pancake.

DR. NOBACK is the one man responsible for maintaining the good health of all members of the animal community. He must supervise the quarantine of newcomers, devise appropriate and adequate diets, maintain sanitary conditions in the animal living quarters, treat the sick, and operate on the surgical cases that arise.

One of the questions people most often ask Dr. Noback is: "How do you handle animals that are sick?"

"Many sick animals," he says, "seem to realize that they are being helped, and cooperate with the doctor. If they are very sick, force is seldom necessary in handling them. But when a tiger or an alligator has a minor ailment—look out. They behave just the way you'd expect—badly."

Not long ago, they cut a tumor from the foot of Old Mose, the park's pugnacious alligator. Old Mose is as slippery as a greased pig and powerful enough to snap off an arm in one bite. A keeper warily approached the unsuspecting reptile and, watching his chance, quickly slid a gunny sack over Mose's head. Helpers rushed forward, knotted a tough rope around those deadly jaws, and lashed the thrashing beast fore-and-aft to a strong plank. With the plank strapped securely against his spine, Mose was under control and the doctor went to work. The growth weighed three and a half pounds.

In major surgical cases, ether, chloroform, and novocaine have been used as complete or local anesthetics, but a new preparation has been successfully tried lately. A compound having barbituric acid as a base is injected with a hypodermic needle directly under the skin or into the peritoneum, the membrane lining the abdominal cavity. In a short time the animal rests quietly, and the doctor can operate safely and painlessly.

It usually takes only a few ounces of ether or chloroform to anesthetize a human being. When Mogul, the Indian rhinoceros, had a delicate eye operation, the doctor was forced to use one and a half pounds of chloroform, *plus* three quarters of a pound of ether to get him "under"!

DIET plays an important role in the treatment of sick animals at the hospital. Irradiated dried milk, eggs, fruits, vegetables, clover, alfalfa, bran, salt, calcium and phosphorus preparations, and bread are only a few of the items on the weekly shopping list.

Occasionally, the problem is to discover not what an animal should eat but what it *will* eat. A pair of rare South American spectacle bears (so called because they look as though they are wearing eyeglasses) arrived at the zoo in bad condition not long ago. Very little was known about their eating habits. They turned up their noses at savory dishes of cooked rice, and ignored a continuous succession of other foods. Finally, the hospital attendant served them a pan of beef stew. After a few preliminary experiments around the rim of the pan, they reached a fa- *(Continued on page 124)*

ZOO HOSPITAL KEEPS RARE ANIMALS HEALTHY

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vorable decision and went to work on the stew.

The intelligence of the monkeys and apes usually makes them the hospital's best patients, but sometimes it is an obstacle. Apes get to know the hospital trick of concealing a pill in the center of a delicious banana. When they suspect this dodge, they patiently pull the banana apart, find the pill, test it with their teeth, and then heave it away, much to the dismay of the attendant.

Not all of the animals can be brought to the hospital for treatment. Some are too big. For this reason, many of the animal exhibition houses have facilities for treating minor accidents and ailments.

DR. NOBACK, however, is always on call. One morning, a keeper reported that a rhinoceros was acting queerly. The doctor rushed over and found the sick beast—one shivering, shaking ton of him—wabbling around his cage. He proved to be docile enough during the examination, and keepers were able to make him lie down. They tucked him in with a few dozen blankets and Dr. Noback dictated a prescription. And what a prescription! None of this business of one teaspoonful in a half glass of water. The rhino got four ounces of cognac in a quart of warm bran mash at every dose.

Elephants occasionally need medical attention. Lack of exercise makes the huge soles of their feet tough and horny. The thick pads crack, and the doctor must pare off part of the sole. Objects sometimes get jammed in these foot cracks. A keeper in the elephant house told me about something that happened one afternoon when all seemed quiet and peaceful. Suddenly, without warning, the air split with the resounding trumpeting of Alice, the Park's prize Indian elephant. Keepers dashed madly for the cage. Alice, trunk up and bellowing with all her might, was holding up her right hind foot, which had a large marble jammed into a crevice in the sole. Attendants quickly yanked the irritant out with pliers and Alice relaxed with a booming sigh of relief.

Most of the snakes' troubles are cared for right in the reptile house by Dr. Raymond L. Ditmars, the curator. Operating on deadly, poisonous snakes is a risky business, but it is sometimes necessary. A short time ago, a keeper discovered that the king cobra was practically blinded by layers of membrane, left on the snake's eyes after it had shed its skin. Dr. Ditmars decided to operate. Cautiously he coaxed and prodded the deadly reptile into a small, screened cage. An attendant warily pushed a stick through the screen and pinned the snake's head against the side of the box. The long, green body writhed and threshed like a snapping whip while the doctor deftly stripped off the tough gray eye scales with a long pair of forceps.

FIGHTS, accidents, and overfeeding are the main causes of sickness and injury at the zoo, but hospital authorities fear an epidemic more than anything else. That is why dogs are not allowed in the park; some of them might be carriers of distemper. Cats also are taboo because they might bring enteritis, an infectious sickness that easily spreads to panthers, pumas, ocelots, and other members of the cat family. At one time the orang-utans were stricken by a violent epidemic of diarrhea, a disease of the intestines. Doctors could not locate the cause of the dread malady until an autopsy on a dead orang-utan showed that germs given the animals by tortoises, then located in the same building, were causing the scourge. The germs were not injurious to the tortoises, so the two groups were quickly separated and the epidemic brought under control.

Always mention POPULAR SCIENCE MONTHLY when answering advertisements in this magazine.

HOME EXPERIMENTS WITH SULPHUR DIOXIDE

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ties of plant and animal (organic) substances, such as wood pulp, wool, silk, and straw are bleached annually by this reducing action of sulphur dioxide. The bleaching effect of this chemical is less injurious to organic structures than chlorine and its compounds.

Along with its bleaching action, sulphur dioxide is also a preservative due to the fact that it readily unites with water, forming sulphurous acid. When added to canned or bottled foods, the sulphurous acid destroys or prevents the growth of molds and other organisms. Its use for this purpose is limited, however, by Government regulations because its effect on the persons eating the preserved foods might be injurious to them also.

Molasses and preserved cherries, properly labeled to indicate the use of a preservative, are the main foods having this form of preservation today.

SULPHUR dioxide also exists in the atmosphere of our cities and big manufacturing centers. When soft coal, which contains sulphur compounds, is burned, these compounds break up and one of the gases formed is sulphur dioxide. As we have seen before, this gas will unite with moisture whenever it gets a chance, forming sulphurous acid. Some of this acid in the air becomes further oxidized to sulphuric acid and these two acids combined do much damage to the respiratory organs of people who live in these locations as well as to outside metal work.

Beautiful crystals of copper sulphate can be recovered from the gas-generating flask after you have completed your experiments with sulphur dioxide. Any sulphuric acid that has not reacted with the copper may be removed by heating the liquid in the flask with additional pieces of copper, or with black copper oxide (cupric oxide). Filter the resulting solution and allow it to crystallize in a warm place. The crystals that you will obtain may be bottled, labeled "copper sulphate," and kept for use in future experiments that call for this chemical

AVERAGE PERSON IS POOR JUDGE OF TIME

"How long is a minute?" To answer this question, 125 persons recently made an interesting time test at the Presbyterian Hospital in New York. In turn, each person was asked to strike a gong, wait until he believed that exactly one minute had passed, and then strike the gong again. The average estimate of the length of a minute was thirty-five seconds. The experiment not only showed the average person a poor judge of time but also contradicted the theory, sometimes advanced, that a person's pulse beat controls his time sense. In this test there appeared to be no direct relation between an individual's pulse and his estimate of a given period of time.

URGE SEPARATED LANES FOR MOTOR HIGHWAYS

ADVOCATING construction of highways that provide separated lanes for cars traveling in opposite directions, the National Research Council points out that on forty miles of road, carrying 1,000 cars per hour each way, there will be about 1,000,000 meetings of cars every hour. The number of such hazards encountered in the course of a year, if calculated, would amount to a staggering astronomical figure. On a twenty-foot roadway, cars commonly pass within two feet of each other, at speeds that would cause certain fatalities in case of a collision. The wonder is, the Council declares, that any of us survive.

WORLD'S CRAZIEST JOBS MAKE MOVIES REALISTIC

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granular form on lead sheets, two to three ounces being reclaimed from each thousand feet. This granular silver goes to the foundry and is smelted in blast furnaces to remove all foreign matter. At a cost of $1,000, a large studio can recover $20,000 worth of silver every year.

One of the most remarkable organizations in the world is a group of professional soldiers who hope they never will fire a real cartridge. In the trappings of British Tommies, German infantrymen, Anzacs, Scottish highlanders, or American doughboys, the "Military Picture Players" appear in many dramas involving war and threats of war. Carl Voss and Walter Vogler recruited 150 former soldiers eleven years ago, and with them provide the military atmosphere for any kind of scene. Voss and Vogler drill the men regularly, discipline them, and guarantee they'll commit no tactical errors. An assistant teaches the manual of arms in nine languages, to make foreign scenes realistic.

SCIENTIFIC advances constantly provide new jobs, both for old-timers and for newcomers who have become skilled in particular lines. With the improvement of three-color photography, there has come a demand for "still" photographs of well-known stars in color. Now, experts record the features and principal costumes of all stars.

These do not represent all the unusual pursuits of Hollywood's unknowns, not by any means. Suppose we skim through a few more. Charles Waldron earns his livelihood by standing in a quiet, sound-proofed room and imitating various birds with his voice, notably parrots, chickens, canaries, and ducks. Later, his voice is "dubbed" in on the film wherever a bird opens its mouth to squawk, cackle, trill, or quack. Marvin C. Bradley, World War officer and now a major in California's National Guard, learned that his military experience could be turned to profit. He rents army trucks and uniforms to the studios, and occasionally furnishes a battalion of troops.

Orrin Cannon trains falcons and directs them. James S. Stembridge has collected hundreds of guns, knives, and scimitars which represent the history of personal combat through the ages. Their rentals provide his living. When not acting as an extra, John Piccori sounds the muezzin's call to the followers of Mohammed as background for Oriental pictures. Grace Yearsley has collected, on records and film, hundreds of varieties of groans, yelps, laughs, squawks, and growls—which she rents for insertion in scenes calling for outlandish sounds.

I COULD go on. One woman weighs chorus girls; a man is detailed to search for scenic clouds as background for outdoor scenes; another launders expensive bridge cards. Winifred McPhee, a wardrobe worker, keeps accurate check on the weight and girth of all stars at her studio, and maintains dummies duplicating them in size by adding or removing layers of cloth as each star gains or loses weight. Thus she can produce costumes which fit the various actors and actresses without personal fittings.

Were you permitted to explore the sound stages and workshops of Hollywood's film factories, the chances are you would find some of these people hard at work, seriously contributing their odd bits to the production of the 700-odd pictures that flow yearly in a never-ending stream to the ends of the earth. Strange tasks, some of these, yet all are performed to the one aim of bringing realism and authenticity to the screen—and each one is essential for the attainment of that perfection which the modern movies seek.

GUS SAYS: GIVE YOUR BATTERY A CHANCE

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ignition circuit and lights. I'll disconnect it, and we'll hook up those three dry cells in that circuit in series just as you've got 'em.

"This time," he grinned, "we'll send a boy on a boy's errand. Those dry cells couldn't possibly work in the starter-motor circuit where a man-size current has to flow, but they'll serve to pep up the ignition voltage where there's only a little-boy current needed.

"You see, when you step on the starter button and you've got a combination like this—ice-cold motor and an old battery—the heavy drain of current on the weakened battery pulls down the voltage so there isn't enough left to force current through the ignition coil and make a hot spark. Putting those dry cells in the circuit will add voltage where it's needed, and the motor ought to start."

GUS reached in and shoved the starter button to the floor with a huge thumb. The starter motor clanked into gear and the engine groaned over a couple of times to the accompaniment of a swishing noise as the choke forced raw gas into the cylinders. Then the engine took hold and started off in fine style.

"We'll keep it running till it warms up a bit," said Gus, "then we'll have to stop it and take those dry cells out of the circuit. They wouldn't last long on that service. Of course, if you say so, we can stow them under the seat and connect them with a single-pole double-throw switch so you can switch them in to ease the starting on cold mornings—only I'd suggest that you put in three new dry cells."

"Fine idea!" Simpson agreed. "By the way, Gus, why is it that an old storage battery won't give so much current as a new one? Seems to me, the more the battery is used, the easier the current ought to slip through it—get sort of broken in, like a bearing."

Gus chuckled. "You're getting a chemical action mixed with a mechanical one," he explained. "If electric current were something solid, like a piston sliding in a cylinder, you could expect it to work better as it was used. But a better comparison for a battery would be water flowing through a pipe. You know how, when you move into a new house, the water runs fast from any faucet. A few years later, it runs a lot slower, because the inside of the pipe has rusted and partly closed up.

"In a storage battery there isn't any rust, of course, but there's something that has about the same effect. That's called sulphate. It gradually forms on the surface and in the pores of the plates and keeps the current from getting at the active material in them."

"CAN'T that be cleaned off, as you clean out a clogged pipe?" Simpson asked.

"Very often, a long, slow charging will get rid of a good part of it," Gus replied. "But the trouble is, by the time the plates get badly sulphated, a lot of other things have begun to happen in the battery that don't improve it any. The insulators between the plates begin to break down; active material in the plates begins to shed and settle to form a thick sludge in the bottom of the cells, and the battery gets to leaking current internally—so badly that if the car is left without use for a couple of weeks you can't start it at all."

"Wouldn't it pay to have the battery overhauled every six months or so to get rid of those troubles?" Simpson suggested.

"It isn't worth while. No matter how carefully you treat an auto battery, it won't last more than two or three years at the outside, and with the price of new batteries so low, the best bet is to get a new one at the first sign of trouble. Once a battery starts to go bad, it gets to the hopeless stage pretty quick, no matter how much you baby it."

CUT-DOWN SQUARE SPEEDS HOUSE FRAMING

The blade of an old steel square is cut off so as to project only 3½ in. The tool is then used like a try-square to mark for studs

IN THE usual method of laying out the studding for frame buildings, the bottom plate is spiked down and the top plate is laid on top, so that the edges of both can be marked at the same time. The position of one stud being located, the others are marked successively by resting the tongue of the square on the floor while the pencil is guided along the edges of the blade. However, the width of the tongue covers the edge of the lower plate, with the result that it receives only one mark unless the square is shifted to make the second mark.

A much better method, which almost doubles the speed of laying out, is to cut off the blade of an old square to project 3½ in., and use the tool like a try-square, with the tongue resting on the top plate. Both sides of the stud can be marked on both plates from one position, and in addition the square can be accurately placed in a shorter time than with the old method.

This is the usual method of laying out studding, but it takes longer

The illustration above shows the ordinary method for purposes of comparison.—EDWIN M. LOVE.

PHOTO TITLES PRINTED FROM TRANSPARENCIES

IF YOU wish to print titles, notations, identifying numbers, or other data on your photographs, yet do not wish to alter the film by writing on it directly, place the lettering on a sheet of cellulose wrapping material slightly larger than the negative, as illustrated above. Print or write the title carefully on it with black India ink. Then set the transparency, reversed, over the negative in the printing frame, to print the lettering in white.—K. M.

SPECTACLE FRAMES SUPPORT MAGNIFIER

MICROSCOPE and telescope eyepieces and the common tripod magnifiers have long been used for microscopic work where a large field of view with medium magnification is desired. By the simple expedient of mounting the eyepiece in a ten-cent spectacle frame, both the operator's hands are freed for use in manipulating or dissecting the specimen. The correct lighting condition is always available, and specimens of every conceivable size and shape can be examined.

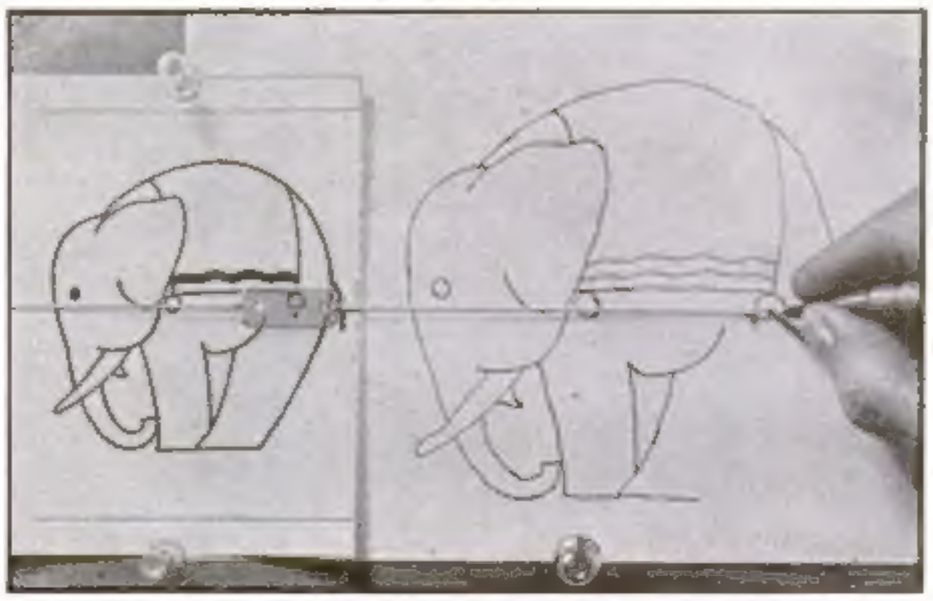
Celluloid frames with circular glasses should be selected, and one or both of the glasses removed. Adhesive tape or a narrow strip of rubber cut from an old inner tube should be wrapped around the eyepiece to be used so that it will fit very snugly in the frame.

If frames cannot be found of the correct size and shape, they can easily be made to fit by placing them in boiling water for a few seconds and then gently bending them while still hot.—L. C. PELTIER.

ENLARGING WITH A RUBBER-BAND PANTOGRAPH

WHEN you wish to enlarge or reduce a drawing and a regular wooden pantograph is not at hand, try the simple method illustrated. All you need is a rubber band, a pushpin, and a small piece of celluloid. Cut the band into two parts, one longer than the other, and tie each to holes in the celluloid. Tie loops in the free ends of the rubber bands, one to be held to the drawing board with a pushpin, and the other to be slipped over the end of a pencil as shown.

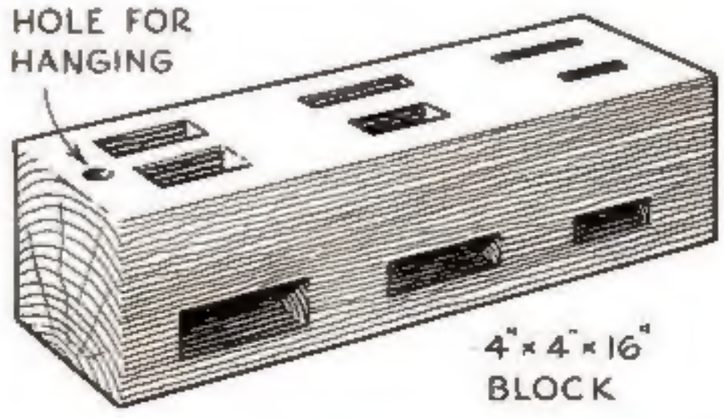
In use, the pencil is moved over the paper in such a way that an ink dot on the celluloid is passed over every line of the picture to be enlarged. The size of the enlargement is determined by the length of the rubber bands and the distance between the drawings. A few minutes' practice is all that is required to enable any one to do reasonably accurate work by this method. School children will find it an easy way to make enlargements of maps and diagrams.—CLIFFORD LEESTMA.



The pencil is moved so that the dot on the celluloid connector passes over each line of the picture being enlarged

HARDWOOD GAUGE BLOCK FOR TESTING TENONS

For testing the tenons used in joining furniture and other cabinetwork, whether they are cut by hand or with a tenoning machine, it is a convenience in any woodworking shop to have a gauge like that illustrated below. This testing block is merely a piece of hardwood of about the dimensions indicated with a number of mortises of assorted sizes.—JOHN BORDEN.



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